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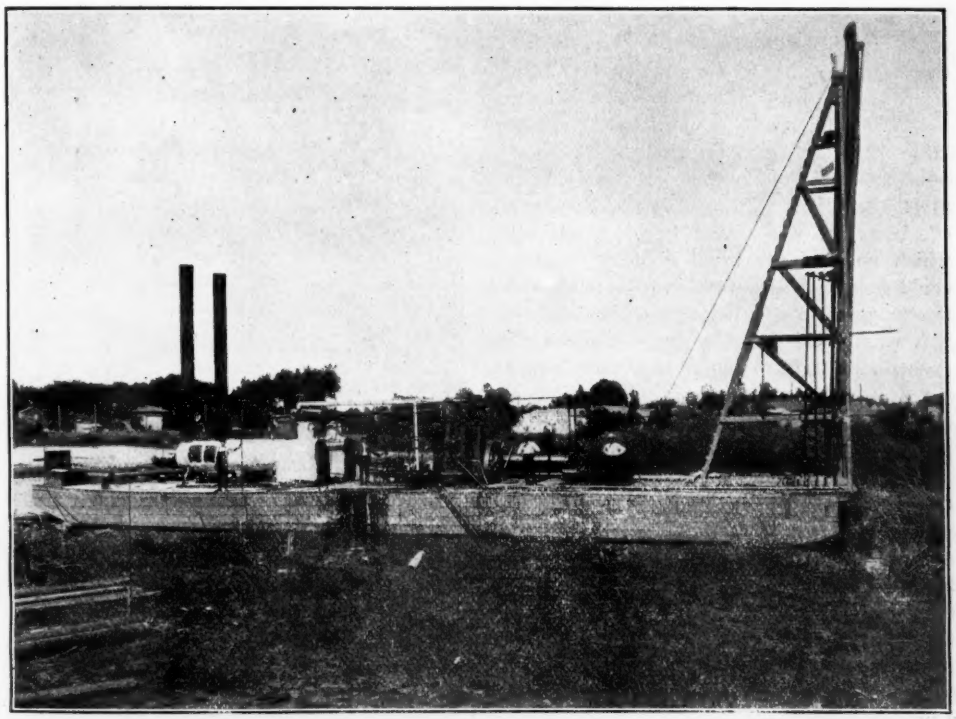
A NOVEL PNEUMATIC DREDGE

California is the land of the gigantic in many things, not the least, perhaps, of which are its dredging problems, which in both character and magnitude challenge the resources of the modern engineer. Dredging has been carried on extensively for a generation and has developed high efficiency and adaptability under the exacting requirements.

Immense deposits of silt have accumulated, largely due to hydraulic mining operations near the head water of the streams, the flood carrying capacities of the channels, originally inadequate, have been greatly reduced and many miles of waterway require to be widened and deepened, the work entailing also the reclamation of over a million acres of fertile lowlands. Hundreds of millions of cubic yards of material must be removed to restore normal conditions or to secure more desirable locations, and the values so created or restored will warrant enormous expenditures.

The general character of the work involved



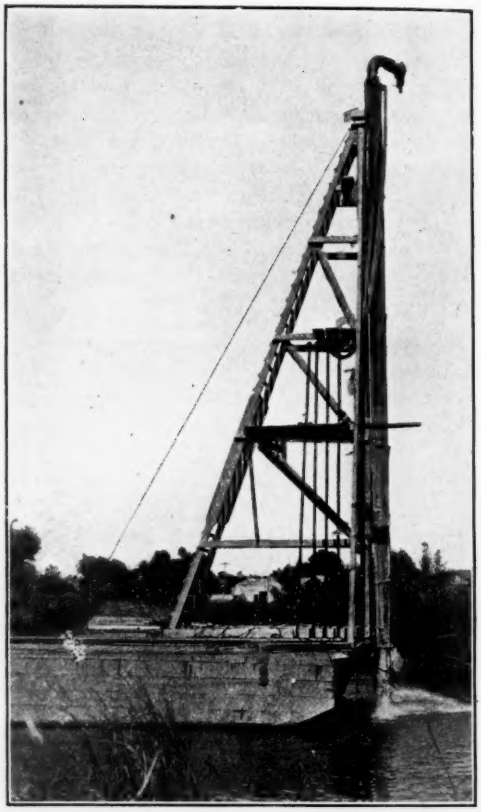
A NOVEL PNEUMATIC DREDGE. LIFTS SAND FROM UNDER 28 FEET OF CLAY.

is not only the lifting of the submerged material but also its conveyance to a considerable distance from the lines of excavation, for the forming of levees which shall give sufficient water areas and restrain future encroachments of either element upon the other. The clam shell and dipper dredges have been extensively used but neither has sufficient reach to deposit the material as required. The efficiency of the hydraulic dredge is recognized, but it is costly to instal, to operate and to maintain, and no satisfactory and economical system has been found until the advent of the pneumatic dredge with its special ability in the hoisting and conveying of sand and other loose material mixed with water.

Great interest is felt in the installation which we here illustrate. It not only demonstrates its high efficiency and cheap rate of working for the general line of service required in this region, but in this case in addition it adapts itself to a special condition of working which all other known devices were compelled to decline. This dredge is now working upon its second contract for the City of Sacramento. The work upon which it is employed is the excavating of a lake and the filling of the adjacent low grounds with the material for the formation of a public park. Although it was required to fill in a large surrounding area the proposition was not an unusual one and seems quite simple in the telling of it. The material to be excavated, however, was found to be a stiff clay, which none of the usual dredging apparatus could handle, and not a bid was received for the work.

It was found that the stratum of clay had a nearly uniform thickness of 28 feet and under this was sand of unknown depth. The operation of excavating for the proposed lake as actually carried on consists in *taking out the sand from under the clay,* and allowing the latter to settle down, giving the depth of water required. This is done cheaply and rapidly by the pneumatic dredge shown in the half tone, Fig. 1. Not only is the sand raised as required but it is discharged at various distances up to 1,500 feet in any direction from the excavating pipe, thus distributing over a large area and bringing the surface to a predetermined level.

The principle of operation of this dredge is that of the now familiar air-lift pump, and all the conditions essential to the successful operation of this device are present. A most imperative condition is a sufficient submergence, and this the nature of the work itself provides. In the case of the clamshell or the dipper dredge a great unbalanced weight of dipper and appurtenances, greater than the load of sand itself, has to be lifted every time, thus more than doubling the power required. In the case of the air lift as here employed there is little more than the pipe friction to be overcome until the surface of the water



EDUCTION PIPE RAISED.

is reached, and the principal work is in the lifting of the material to the height above the water level required for the discharge. This sufficiently accounts for the high comparative economy realized by the apparatus.

On the scow or barge as shown there are two locomotive boilers, using oil for fuel, an air compressor, two steam pumps for water, a hoist and an A frame with vertical guides

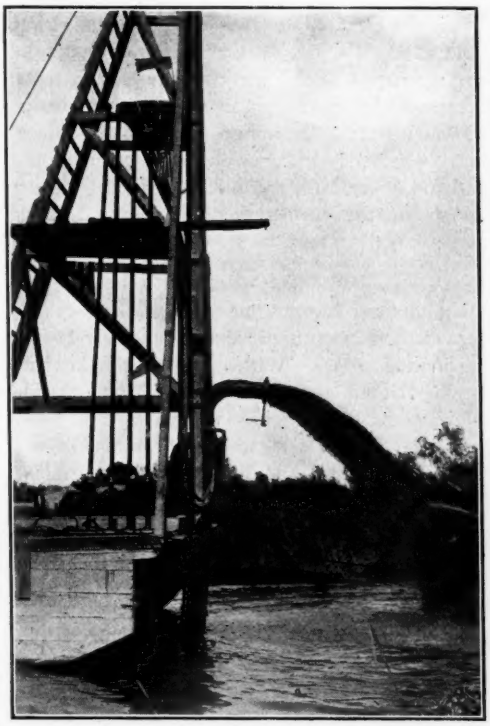
for the eduction pipe. This pipe, 10 inches in diameter and 50 feet long is provided with a "head" on the lower end about four feet long and eighteen inches in diameter, containing sufficient openings to admit a plentiful supply of water, sand, mud, etc., when in operation. Two inch air and water pipes plentifully supply the head with air and water. These are carried in iron pipes to about one half the height of the A frame, and the hose provides a constant connection whether the eduction pipe is up or down. The air is the lifting force and water is used only for the sinking of the pipe and to dilute or stir up the sand to a suitable consistency for transmission through the discharge line.

For sinking through the clay the pipe is raised and dropped like a pile driver ram, the water keeping the head clear, and when the clay is passed through the sand begins to be brought up at once. Fig. 2 shows the pipe raised to the top of the A frame and its lower end clear of the water. Fig. 3 shows the pipe down to its sand lifting position and gives an idea of the character of the discharge. Pipes are still to be coupled to the nozzel to deliver the sand at a distance. This pipe should be level or descending all the way from the lift, and spiral piping gives the best results.

Owing to the high percentage of solid matter—sand, silt or gravel—raised it was found that the horizontal transmission for long distances might present insurmountable difficulties; but trial has demonstrated that there is no trouble in forcing the water and sand with the original pressure, this pressure being slightly greater than required by the hydrostatic head at the submerged depth. In free moving sand, silt, muck, etc., the per centage of solid matter discharged ranges from 25 to 50 per cent. In the operation of the dredge here shown about 750 cubic feet of free air per minute was required at a gage pressure of 20 to 25 pounds. Three men did all the work of the shift and with two shifts from 1,200 to 2,000 cubic yards, were delivered per day.

It is suggested as an important advantage of the pneumatic system of dredging that a dozen or more dredges could be operated from a central compressing plant. In this case no boiler or fuel would be required upon the barges, as pumps, hoists and all would be air driven.

Mr. M. A. Nurse, for twelve years State Engineer of California, says: "I feel assured from, my wide experience in dredging and reclamation work in the State of California,



DISCHARGE OF SAND AND WATER.

that the pneumatic dredge is the simplest and most economical method of handling all forms of sand, silt, muck, clinkers, gravel and sedimentary deposits which can be loosened by the action of a hydraulic jet. Sedimentary deposits can be raised from any depth below the water level and transported several hundred feet with one operation and at a cost which will allow the device to compete with any other dredging machine now in use. Where gold values are found in sedimentary soil the pneumatic dredge will prove a very efficient device for gold dredging. It will operate in many cases where the ordinary bucket dredge is useless."

For the photos and the information contained in this article we are indebted to Mr. Elmer E. Corey, of Sacramento.

WOOD PRESERVING PROCESSES

A Primer of Wood Preservation, Forest Service Circular No. 139, is an interesting and important addition to the list of pamphlets issued by the Department of Agriculture for the dissemination of practical information bearing upon our industries and resources.

In the United States creosote and zinc chlorid are the only preservatives in common use. Just as there are two preservatives in common use, so there are two principal methods in injecting them into the timber. These may be called the "pressure-cylinder method" and the "open-tank method." A third process, known as the "brush method," is used to a more limited extent.

THE PRESSURE PROCESS.

Up to very recent times the pressure-cylinder method was used almost exclusively in the United States. With creosote it is known as the Bethell process, and with zinc chlorid the name of Burnettizing is applied. The timber to be treated is placed on iron trucks or "cylinder-buggies" and drawn by steel cables into huge horizontal cylinders, some of which are 8 or even 9 feet in diameter and more than 150 feet long. These are capable of withstanding high pressure, and their doors are so arranged that, after the timber is drawn in, they can be closed and heremetically sealed. It is the common practice in this country—a practice with long experience in Europe, as well as in America, has proved to be unwise—to treat the timber before it has had time to dry out in the open air. The following is the usual method. After the doors are closed live steam is admitted into the cylinder, and a pressure of about 20 pounds per square inch is maintained for several hours, the exact time depending upon the individual opinion of the operator, as well as upon the moisture content and size of the timber under treatment. In some cases the steam pressure is allowed to go considerably above 20 pounds, but there is constant risk of injurying the strength of the timber. When the steam is at last blown out of the cylinder, the vacuum pumps are started and as much of the air as possible is exhausted from the cylinder and from the wood structure. This process also continues for several hours. Finally, after the completion of the vacuum period, the preservative is run into the cylinder and the pressure pumps are started and continued until the desired amount of preservative fluid is forced into the wood. The surplus preservative is then blown back into the storage tanks, the timber is allowed to drip for a few minutes, and finally the cylinder doors are opened and the treated timber is withdrawn.

THE OPEN-TANK PROCESS.

The injection of the preservative by the open-tank process depends upon a different principle. The wood is first thoroughly seasoned, and much of the moisture in the cells and intercellular spaces is replaced by air. If the timber is peeled soon after cutting, and stacked in open piles, the time required for seasoning can be greatly lessened. The seasoned timber, or that portion of it which is to be preserved, is immersed in a hot bath of the preservative contained in an open iron tank. This hot bath is continued for from one to five or six hours, depending upon the timber. During this portion of the treatment the air and moisture in the wood expand and a portion of them pass out, appearing as little bubbles on the surface of the fluid. At the end of the hot bath, as quick a change as possible is made from the hot to a cold preservative. This causes a contraction of the air and moisture remaining in the wood, and, since a portion of it has been expelled, a partial vacuum is created which can be destroyed only by the entrance of the preservative. Thus atmospheric pressure accomplishes that for which artificial pressure is needed in most of the commercial plants. Whether the open-tank or pressure-cylinder method is the more desirable depends upon the particular conditions of each case. Both methods have their particular uses and neither can always be wholly substituted for the other.

Still there are some architects who are so far behind the times that they do not know stone can be had cheaper than face brick in many of the markets. Time was when cut stone was very costly, and so it is generally considered, but with the improvement of equipment for the cutting shed as well as the quarry [pneumatic tools especially, Ed. C. A.] this is no longer the case. Richest carving and even elaborate designing is now in the reach of moderate building appropriations.—*Rock Products.*

GOLD MINING AS A NON-SPECULATIVE BUSINESS AND AN EXACT SCIENCE

William L. Saunders, President of the Ingersoll-Rand Compnay, is reported as follows by an interviewer in the *Wall Street Summary*:

"The gold mining interest is establishing new high records of production at low costs of operation. The numerous remarkable inventions, discoveries and improvements in mining which have marked recent years enable operators to extract more gold per ton of ore and at considerably lower costs. These inventions and discoveries and the many improvements in the administration of mines have practically added billions of dollars to the estimated valuations of our mines of the various metals. Gold, silver and copper ores which, a few years ago, were regarded as not worth working, are now eagerly sought for by the refining interests. Mining is somewhat like farming, in that it is a business that can always find quick cash markets for its products. The mining interests of this country have saved all of us from what looked like a long period of commercial depression, as the most sagacious financiers saw the business prospect last year. Our gold production has exerted a most powerful energy in the uplift of the industries of the whole country.

"The gold production in the United States for this year will go well above the $100,000,000 mark. A few years ago, the best informed gold miners did not consider it within reason to predict an output of that amount before 1915. Notwithstanding the enormous expansion in the world's production of gold, there is an ever growing demand for it, and the price year after year is steady at the value of a fraction more than $20 per fine ounce.

Within a short time I was with a party of engineers and manufacturers who visited a number of gold mines. We saw at one camp gold ore in sight to the value of $30,000,000. At other camps in that region we saw almost as large visible supplies. The quickening of business, which is happily going on throughout our land, is in great part due to the tremendous energies of our mine operators, who kept right on developing and marketing products despite the stormy financial skies of last year. Those men who kept right on adding enormously to the resources of the country demonstrated practical patriotism that everybody ought to appreciate.

"Our rapid advance in gold output began in 1892. There was a temporary setback from 1901 until 1904, when the increase in gold production was $7,000,000 more than the previous year. When silver mining was hard hit a few years ago, croakers said that the silver interests was almost destroyed. But the silver mine operators were made of sterling metal. They went right ahead and engaged in gold and copper mining. In the case of Colorado, where years ago the silver interest was far and away the largest, the transfer of energies to gold has made her gold worth much more than her silver mining interest.

Silver mining has a great future. The great silver using countries are making forward strides in population and in increase of the purchasing power of units of population. The expansion of gold production is helping the silver, copper, lead, iron and other mining industries; and, in fact, is stimulating the increase of the material well being of people in all lands. Our gold mines' ever increasing production is a powerful factor in placing us high for credit in foreign money markets. Increasing gold production has forever laid to rest that vexatious question which, under various guises, pledged us for years under the common name of the two metals currency question. But for our great showing as owners and operators of gold mines, we could not have gone ahead and adopted the gold standard, which helped us in the borrowing of the immense amounts of money abroad that have been put to profitable use in developing resources that are worth billions to us. Mexico, a great silver producing country, adopted the gold standard chiefly to advance her credit abroad. That object was accomplished in such volume as to place her far forward in the ranks of Nations that are highly prosperous.

"It is remarkable that in a community like New York, which is most largely engaged in ordinary merchandizing at very small profits, there are so many men who regard mining as a speculative business. Mining is an exact science devoted to strictly commercial ends, and it is by far the most profitable business in

the world. Speculation is a very small factor in mining. No other interest has paid, or, is likely to pay, so well upon the capital invested as legitimate mining. Compare the results from investments in railroads for many years with the annals of sound mining, and it is easy to see that railroading, in comparison with mining, may be termed a speculative pursuit, whereas mining has made a record that places it among the steadiest dividend-earners known in modern times. Mining is on the eve of a great forward movement of mine improvement. So far as I know, there is not likely to be a setback in the recent improvement in the market for mining machinery.

"Iron cloth" is now used by American tailors for stiffening collars, etc. It is manufactured from steel wool, and looks like horsehair.

OXY-ACETYLENE WELDING AND CUTTING*

The highest temperature of the best solid fuel furnaces is about 3,000 F. The oxy-hydrogen, which was the hottest of the gas flames, is something less than 4,000 F. The oxy-acetylene flame jumps this temperature more than 2,000 F. to about 6,300 F., being more than double the hottest solid fuel heat known. As acetylene produces about five times more heat per cubic foot than hydrogen, and nearly doubles it in intensity, a marvelously powerful flame is condensed into very small volume. Compared to the oxy-hydrogen flame, it is like a finely-pointed tool to a blunt instrument. With such a tool, having heating power from two to three times that required to melt the commercial metals, almost incredible results are obtained. Steel, cast iron, aluminum, brass, copper and other metals can be so perfectly united that when smooth the joint cannot be discerned. Containers for fluids and liquids can be made without joints, and will not leak when bruised or dented. Blow-holes and other defects in iron, steel, brass and other castings can be repaired, not only saving the castings, but many times expensive machine work as well. Quickly repairing broken machines, boilers and steam and other piping in place is one of the most valuable features of this process. Worn parts of machinery and teeth on gear wheels can be built up; tool steel added to common steel; dies repaired, and numberless other operations accomplished which are not possible by other methods. Not only similar metals but those of different kinds can be perfectly united.

The facility with which steel and iron (except cast iron) can be cut is really marvelous. The operation is performed by heating the metal at the first point of contact to the red by the ordinary welding flame, and with this flame continued, a jet of pure oxygen is turned on which unites with the carbon of the metal and disintegrates it with surprising rapidity. The cut is narrow and smooth, with no material injury by oxidation. The cut can be made in any shape, and the process will be found very useful in cutting irregular forms, and will be valuable, especially in making many kinds of dies and in fitting steel plates. It is very effective for cutting steel beams in structural work.

The A. Boas, Rodrigues & Co. torch, known here as the Davis-Bournonville, has been improved in design and construction until it is now practically perfect. All of the authorities have given 2.5 parts of oxygen to 1 of acetylene, as the theoretical quantities required, and 1.8 of oxygen to 1 of acetylene, as the quantities actually used in practice. With their apparatus and torch the Davis-Bournonville Co. has succeeded in securing a perfect welding flame, with only 1.28 parts of oxygen to 1 of acetylene, not only effecting a very material saving in the cost of operation, but obtaining better results as well. An imperfect mixture of gases is not only much more expensive, but an excess of oxygen oxidizes the metal, and too much acetylene carburets it, either condition being seriously detrimental.

The table on the opposite page, showing the approximate cost of cutting and welding will be of interest to investigators.

*From a paper by Augustus Davis before the Chicago meeting of the International Acetylene Association.

It is stated that the Georgia Marble Company, Tate, Ga., throughout the recent prevailing slackness did not lay off any men nor cut their wages.

APROXIMATE COST OF OXY-ACETYLENE WELDING.

Oxygen at three cents—Acetylene at one cent per cubic foot. Labor 30 cents per hour.

Tip Number	Thickness of Metal	Consumption of Acetylene Per Hour	Consumption of Oxygen Per Hour	Proper Pressure in Pounds for Oxygen	Lineal Feet Welded Per Hour	Cost of Labor Per Hour	Total Cost Per Hour	Cost Per Lineal Foot
1	1/32 to 1/16	2.8 feet	3.6 feet	8 to 10 lbs.	50 feet	.30 cents	.436	.0087
2	1/16 to 3/32	4.5 "	5.7	10 to 12 "	30 "	30 "	.516	.0172
3	3/32 to 1/8	7.5 "	9.7 "	12 to 14 "	25 "	30 "	.666	.0266
4	1/8 to 1/4	11.7 "	15. "	14 to 18 "	16 "	.30 "	.867	.054
5	1/4 to 1/16	18. "	23. "	18 to 22 "	10 "	.30 "	1.17	.117
6	1/16 to 7/8	25. "	32. "	20 to 25 "	7 "	.30 "	1.51	.216
7	7/8 to 1/2	32.5 "	41.5 "	22 to 27 "	5 "	.30 "	1.87	.374
8	1/2 upward	48.5 "	62. "	24 to 30 "			2.64	

APPROXIMATE COST OF CUTTING STEEL.

Number Cutting Tip	Use Welding Tip No.	Thickness of Steel	Heating Jet. Feet of Acetylene	Heating Jet. Feet of Oxygen	Cutting Jet. Feet of Oxygen	Pressure of Oxygen Heating Jet	Pressure of Oxygen Cutting Jet	Lineal Feet Cut Per Hour	Labor Per Hour	Total Cost Per Hour	Cost Per Lineal Foot
1	4	up to 1/2"	12	15½	60	14 to 18 lbs.	125 lbs.	60	.30	2.68	.0447
2	4	1/2" to 1½"	12	15½	75	14 to 18 "	125 to 150	50	.30	3.13	.0627
3	5	1½" up	18	23	75	18 to 22 "	150 to 175	40	.30	4.02	.1005

FUEL COST OF POWER AIR HAMMERS

The use of compressed air for driving hammers in blacksmith shops, boiler shops, etc., where steam has usually been employed, is rapidly extending, especially in Great Britain, and information concerning the cost and other conditions of operation is welcome. The following letter to *The Engineer,* London, is from Mr. T. Scott King and it speaks with indisputable authority concerning the performance of the N. S. K. hammer of which the writer is a joint inventor. The results as given in the tables shown are actual saving in power cost when operating with air, and the other accompanying advantages should make the air service extremely desirable for this purpose. The letter follows:

SIR:—The article on "Steam *vs* Compressed Air" in your issue of April 17th last [see *Compressed Air* for July, page 4937] based on results tabulated in Messrs. B. and S. Massey's steam hammer catalogue, assumes that as there is no gain in working expansively in steam hammer cylinders, the same holds good of hammers using compressed air, and under these conditions proceeds to demonstrate that the fuel cost of operating steam hammers is less than buying electrical energy to compress air, whereas in the N. S. K.—Norris and Scott King—compound pneumatic hammer manufactured by Messrs. Peter Pilkington, Limited, Bamber Bridge, near Preston, compressed air is expanded to three or more volumes, resulting in an economy of 50 per cent. in the size of compressors and driving power.

It is not necessary to refer to the construction of this hammer except to state that air under pressure is admitted to the fixed space formed under the tup piston when raised to its highest working position. The inlet port to the striking piston is then opened and the air flows from the underside, and acting on the larger area is expanded in accelerating the falling tup. Reference to Tables, I and II. will show that in 1,000 strokes the 5 cwt. steam hammer has a displacement to atmosphere of 1,258 cubic feet, as compared with 861 cubic feet displacement on an equal size N. S. K. compressed air hammer. In the Massey statement, steam pipe condensation is allowed for, but cylinder losses are ignored, and, being the greater, vitiate the economy claimed for the steam hammer to a very serious degree.

Economy in the use of steam in cylinders is to be obtained by constant running at high speeds with small clearances, reducing the masses of metal and radiating surfaces to a minimum, superheating the steam and using a high ratio of expansion. It is wisely stated in your article that only very slight expansive working is possible in steam hammer cylinders, for undoubtedly the steam hammer

is working under best conditions when admitting steam at full pressure to the striking cylinder. The every day working conditions of a smithy hammer are dead against steam economy, for the power agent depends for its efficiency upon the maintenance of a high temperature, whereas the work is intermittent, leading to condensation in the conveying pipes and great liquefaction in cold cylinders. And, further, there is no hope of improving the economy of steam hammers, for compounding and superheating add complications without compensating gain. There is one feature of great loss in striking dead or maximum blows non-expansively, viz., that during the fall of the tup at high velocity, the air or steam usually conveyed in lengthy pipes cannot maintain the full pressure in the striking cylinder, and consequently there is a considerable "drop" between the average pressure acting in the striking piston and the pressure in the boiler or air receiver. The trouble, however, does not end here, for when the blow has been struck the air or steam continues to flow into the cylinder until the full pressure is reached, and although the energy of the blow struck is determined by the falling weight and average pressure acting on the piston, an increased pressure is thus afterward admitted to the cylinder uselessly.

This loss is entirely avoided by using a fixed ratio of expansion in the N. S. K. compressed air hammer when striking normal blows, and an additional inlet port is provided for striking dead blows, which, under like extraneous conditions, gives 58 lb. per square inch average pressure, against 49.8 lb. per square inch when admitted through the usual single inlet port.

A comparison of Tables I. and II. shows that when supplied with steam at 85 lb. pressure generated with coal at 10s per ton, the 5 cwt. steam hammer costs for fuel three times as much as the N. S. K. compressed air hammer working non-expansively and 5½ times more than the N. S. K. when used expansively doing equal work.

This result is obtained from an engine using producer gas and giving 7½ brake horse-

TABLE I.—*Fuel Cost of Operating Steam Hammers, Heavy Forge Type.*

Condition of working	Non-expansively
Nominal catalogue rating	5 cwt.
Diameter of striking piston	9in.
Diameter of piston-rod	5½in.
Area of striking piston	63.62in.
Net lifting area of piston	39.36in.
Stroke of tup, full stroke	1ft. 9in.
Weight of falling mass	560 lb.
Working pressure, gauge	85 lb.
Average pressure on striking piston	50 lb.
Net exhaust displacement to atmosphere of striking and lifting pistons in 1000 full length blows	1258 cub. ft.
Pressure in cylinder when blow has been delivered, gauge	85 lb.
Energy in foot-lb. at moment of impact, 1.75 (63.62 × 50 + 560)	= 6546.75
Net weight of steam exhausted from the striking and lifting cylinders in 1000 full length blows; the cylinder condensation and missing quantity being taken at 100 per cent. to allow for the intermittent character of the work and the constant losses in heating up a cold cylinder, valve chest, &c., $\frac{1258 \times 2}{4.33}$ = lb. of steam	581.4
Evaporative duty being taken at 5 lb. of water per lb. of coal to cover stand by losses on boiler and condensation in pipes $\frac{581.4}{5}$ = lb. of coal necessary to to strike 1000 full length blows	= 116.3
Cost of coal per 1000 blows at 10s. per ton	6.23d.
" " " 17s. 6d. per ton	10.9d.
" " " 25s. per ton	15.575d.

A comparison of Tables I. and II. shows that when supplied with steam at 85 lb. pressure generated with coal at 10s per ton, the 5 cwt. steam hammer costs for fuel three times as much as the N. S. K. compressed air hammer working non-expansively and 5½ times more than the N. S. K. when used expansively doing equal work.

This result is obtained from an engine using producer gas and giving 7½ brake horse-

TABLE II.—*Fuel Cost of Operating N.S.K. Compressed Air Hammers, Heavy Forge Type.*

Conditions of working		Non-expansively	Expansively
Nominal catalogue rating		5 cwt.	5 cwt.
Diameter of striking piston		9½in.	9½in.
Diameter of lower differential piston		7⅞in.	7⅞in.
Net striking area of piston		47.17in.	47.17in.
Net lifting area of piston		23.71in.	23.71in.
Stroke of tup		1ft. 9in.	1ft. 9in.
Weight of falling mass		791 lb.	791 lb.
Working pressure		85 lb. sq. in.	85 lb. sq. in.
Average pressure in striking piston		58 lb. sq. in.	24 lb. sq. in.
Terminal pressure in striking cylinder after blow has been delivered		85 lb. sq. in.	16 lb. sq. in.
Net displacement of striking cylinder to atmosphere per 1000 full length blows		861 cub. ft.	861 cub. ft.
Net displacement in terms of free air to atmosphere per 1000 full length blows		5740 cub. ft.	1779.4 cub. ft.
Energy in foot-lb. at moment of impact: Non-expanding 1.75 (47.17 × 58 + 791)		= 6172 ft-lb.	
Expanding 1.75 (47.17 × 24 + 791)		—	=3365.25 ft.-lb.
Power to compress 6000 cub. ft. of free air per hour to 85 lb. gauge pressure in compound water-cooled cylinders and inter cooler		15.75 B.H.P.	15.75 B.H.P.
Cost of compressing air as above, with producer gas to supply hammers working non-expansively and expansively, as described and corrected for equal work, viz., 6546.5 foot-lb. per blow	No. of B.H.P. for 1d.		
	7½	2.04d.	1.16
	10	1.53d.	.87
	12½	1.224d.	.696
	15	1.02d.	.58
Electrically-driven compressor, 72 per cent. combined efficiency of engin and generator.			
Coal burnt per I.H.P.	2	3	4
Cost of coal per ton	25s.	17s. 6d.	10s.
Index mark A B C			
Cost of compressing air as above, with electrically-driven compressor to supply hammer under stated conditions, and corrected for equal work, viz., 1000 – 6546.5 foot-lb. blows	Index mark.		
	A	5.68d.	3.23
	B	6.0d.	3.4
	C	4.54d.	2.58

power for one penny per hour. In taking out fuel costs for electrically-driving compressors, the cheap coal has been allocated to the less economical steam plant and *vice versâ*, for it is assumed that in districts where coal is dear some effort would be made to economise by the use of more improved steam plant.

One thousand full-weight blows with the 5 cwt. steam hammer cost 6.23d., with coal at 10s. per ton, rising to 15.575d., with coal at 25s. per ton, whereas with electrically-driven compressor the N. S. K. hammer will do equal work ranging from 2.58/6d., according as to whether the air is used expansively or non-expansively.

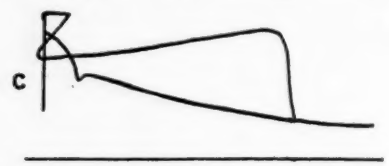
In compiling Tables I. and II., the comparison is based on piston displacements, for the cylinder and port clearances of the air and steam hammers are approximately equal. The comparison is purposely made on fuel costs, for usually the power required intermittently for working hammers is an adjunct to a main power scheme, and the capital and other charges are pertinent to the major rather than to the minor.

Dead Non-Expanding Blows

Lifting Piston

Striking Piston

Full Normal Expanding Blows.



Lifting Piston

Striking Piston

7¾"x9½" Cyliners. Nominal 5 Cwt N. S. K.
21" Stroke. Weight of Falling Parts 7c. Oq. 71.
Scale 1-112. Receiver 85 lbs.

The diagrams A and B are taken from 5 cwt. N. S. K. hammer, striking dead blows and using compressed air non-expansively

The diagrams C and D are taken from the same hammer working compound and striking normal full-weight blows for general smith's work. The compressed air is expanded from 100 lb. pressure absolute down to 31 lb. absolute. The rise of pressure will be noted at X on the striking card B and its absence at the terminal of expansion on Card D.

A NOVEL HYDRAULIC AIR COMPRESSOR

To compress air by the direct pressure of water to, say, 85 lbs., gage, which is about the pressure commonly used for operating rock drills and pneumatic tools, requires two hundred foot head for the water. If water with this head were turned directly into a tank full of air it would compress the air and force it out at the required pressure, but it would entail an enormous waste of energy. The volume of water used would be somewhat in excess of the volume of free air compressed. The loss of power would be distributed throughout the operation of compression until the terminal pressure was reached, the losses being greatest at the begining of the compression. To compress the air without this loss of the potential energy of the water it would be necessary that the water pressure should be only sufficient to do the immediate work or to overcome the pressure at the moment.

The compression might begin with, say, only a couple pounds of water pressure, this gradually increasing to 16 lbs. when the tank was half full of water, to 46 pounds when it was three quarters full, increasing thence to 86 lbs. when the tank was 85 per cent. full, and then this full water pressure continuing until the compressed air was all expelled into the receiver. The contact of the water with the air may warrant the assumption of isothermal compression, and then the above may be taken as a sketch of the ideal economical employment of water as the agent, and the invention here to be spoken of, the essential feature of which will be understood from the cut, undertakes to approximately adjust the water pressure to the varying resistance by intermingling with the normal supply varying proportions of dead water according to the varying elastic resistance of the air.

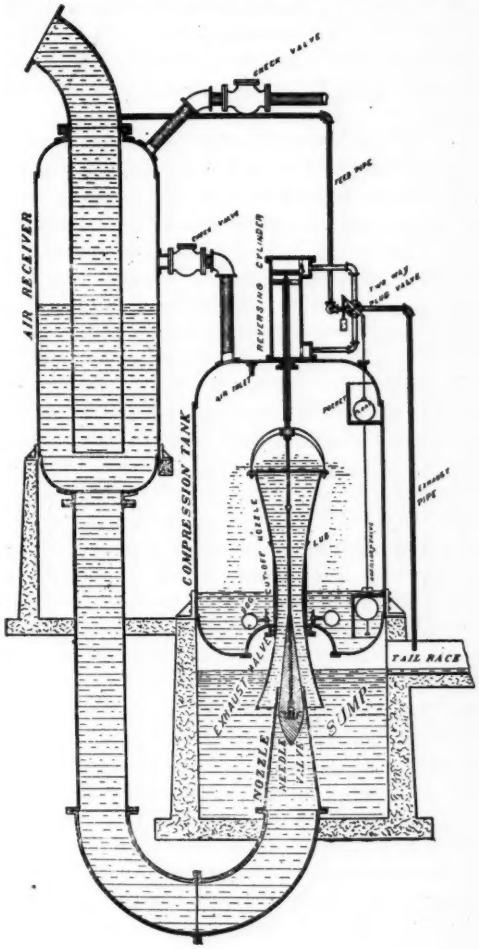
This system, for which a U. S. patent has been granted, is the invention of Mr. George C. MacFarlane, Saginaw, Mich., and the description following is mostly furnished by the inventor.

A nozzle or "monitor" connected with a head of water, produced either by gravity or by a turbine pump, is mounted under an air tank. By an arrangement of a shifting cut-off nozzle and a needle valve, the stream issuing from the monitor sluices in enough dead-

water from the sump to reduce the velocity head of the stream entering the tank to correspond to the air pressure it must overcome. In the initial stages a small opening of the nozzle sluices in a big stream of dead-water from the sump, in the final stage the needle valve gives a full opening of the nozzle, while the cut off valve shuts off all or nearly all the dead-water. Of course in a case where the water pressure greatly exceeded the air pressure it was desired to maintain, a considerable amount of dead-water would have to be admixed with the live head even in the final stage of compression.

The cut shows the operation of the system when using a gravity water pressure. The pipe head passes down through and nearly to the bottom of the air receiver; from the receiver the water is conducted down a pipe, through a return bend and up into the nozzle, whence it is periodically admitted into the compression chamber. The nozzle is opened and closed by a needle valve, and a vertically moving cut-off nozzle regulates the amount of dead-water admitted with the live head. Both the needle valve and the cut-off are moved up and down by separate pistons operating tandem in one reversing cylinder; their movements being controlled by floats, which operate a two-way plug controlling valve, to admit water above or below these pistons. An exhaust valve for quickly emptying the tank is raised by the upward movement of the cut-off nozzle, the receding water level releases the float-operated dogs and permits the exhaust valve to drop back into place when the tank is nearly empty. The floats that move the controlling valve work in pockets and give a quick reverse to the valve. The cycle of operation is as follows:

Starting with a tank full of air, which the receding water level has drawn in through the inlet ports on top of the tank, the bottom float being down, the controlling valve directs the feed water into the upper port of the reversing cylinder; this shoves both pistons down, lowering the needle valve and cut-off nozzle. As the water flows into the tank, compressing the air, the rising water level raises an auxiliary valve against the drain holes in the upper pocket, and no water can enter the upper pocket until the water level reaches the top of the pocket, when it overflows and quickly throws up the float, reversing the controlling valve, which now directs the feed water into the lower port of the reversing cylinder. Now since the lower piston head rests tight against the lower cylinder head, the force of the water is expended in raising the upper piston, which closes the needle valve; near the end of this up stroke, a dog nut on



MAC FARLANE AIR COMPRESSOR.

the needle valve stem engages the bottom of the hollow rod of the lower piston, raising it enough to clear the lower cylinder port.

The lower piston now catches the full water pressure and the cut-off nozzle and the exhaust valve are raised. As the tank empties the receding water level releases the exhaust valve dogs permitting the valve to close; the lower float also drops; reversing the controlling valve, and beginning a new cycle.

Each cycle would require ordinarily about fifteen or twenty seconds to complete, and a nearly constant air pressure would be maintained in the pipe line throughout the cycle by the water level in the air receiver rising and falling. When a charge of air was shoved in to the receiver from the compressing tank, the water level would be lowered; then as the air flowed into the pipe line, water from the pressure main would flow into the air receiver, thereby maintaining a nearly constant air pressure.

It will be seen that this compressor is simple and compact in design and should be constructed and installed at a comparatively low cost per unit; it also possesses the advantage of high mechanical efficiency. The smooth lines of nozzle and cut-off offer very little frictional resistance to the inrushing water, very little energy is needed to actuate the valve and cut-off, and a relatively small amount of the total energy is lost in the inertia of the water discharged from the tank.

While the special field of this system is direct compression from natural heads of two hundred feet and over; it can also be used advantageously in conjunction with an artificial head produced by a multi-stage turbine pump, and the inventor suggests that where the prime mover is a steam or water turbine, an electric motor, or a line shaft, it will often be more convenient and economical to connect a multi-stage turbine direct to the power and compress by this system hydraulically, rather than to belt or gear on a reciprocating compressor. In comparing the efficiency of the two systems, it should be borne in mind that the hydraulic system requires no auxiliary pump to circulate cooling water, exerts a uniform resistance on the driving motor, compresses the air at a lower temperature, and the air delivered is drier and free from lubricating oil.

COMPRESSED AIR IN LAUNDRY WORK

The application of air compressors to laundry work has invariably been successful, and the demand for them for such service is increasing. Generally speaking, it is always a two-pressure service, a very low pressure for use with gas burners, sprayers, and heated rolls, and a higher pressure for presses used in the dampening process.

Two laundries may be taken as fairly representative of modern practice in this line, and a description of their air plants are as follows: One of these plants makes a specialty of hand work, having about 50 hand-ironing boards, and four rolls of ironing machines. Each ironing board is provided with a flat-iron heater and connected to both gas and low-pressure air supply. By properly regulating the admission of gas and air, a very hot blue flame is obtained throughout the interior of the heater and, of course, this flame can be adjusted to give any degree of heat desired. Rolls of ironing machines or mangles are similarly heated by jets of gas and air.

All of the above devices use air at three or four pounds pressure. There is one press, the cylinder of which is 8 inches in diameter and 24 inch stroke. It is vertical and supported by columns at a height sufficient to allow trucks with boxes about two feet square and three feet high to be run under it. After the clothes are dampened, they are placed in these box trucks until the box is nearly filled. A cover is then placed over the top of the clothes and the truck is run under the press. The air pressure used is 50 pounds.

They also have hose connections on each floor, connected with the high-pressure supply, for cleaning out their motors and machines. (All machines are run by individual electric drive.) They also use the high-pressure air for blowing whistles on each floor at the time of starting and stopping the plant.

Their compressor plant consists of a 9½ x11x10 inch air compressor with plain air cylinder, controlled by a governor set at 55 pounds, and mounted on the end wall of the building on the second floor. Boiler pressure is 100 pounds, and the exhaust is used for heating the building and feed water. The air inlet to the compressor is piped through the top of a window nearby. The air is discharged into two 26½x54 inch reservoirs coupled in series. Both high and low pressure air lines are taken from the second reservoir, a reducing valve controlling the low-pressure line.

The pipe lines run along the walls near the floor, and under the floor to each machine. The ironing boards are placed mostly along the walls at right angles to them and connected to both air and gas lines directly by small rubber hose. The size of air pipe lines

varies from 1 to ⅜ inch, the size being reduced at intervals as the distance from the compressor plant increases.

The free air consumed by these various devices cannot be stated so as to form a general rule, since different operators regulate their gas flames differently. But it is noted that when about 20 or 25 ironing boards and 4 rolls were in continuous operation, the pump indicated a consumption of from 16 to 20 cu. ft. of free air per minute, approximately.

The management of this laundry is highly pleased with the compressor plant, and stated that their business has increased 20 per cent. during the time since the compressor was installed, while their gas bills had been reduced 20 per cent. by the introduction of compressed air, or a saving of 33 ⅓ per cent. in gas consumption had been effected by this means.

The other establishment mentioned does general laundry work, having about 20 ironing boards and 12 rolls. (They also have 3 or 4 mangles, but heated by steam.) Their low-pressure line is carried at 33 pounds.

They have two presses, one 5 inch diameter by 18 inch stroke, and one 8 inch diameter by 24 inch stroke. These presses are placed on the floor and press upward; the patent box trucks are not used, the clothes being placed in a frame that is a permanent part of the top of the press. When the frame is nearly filled, pressure is turned into the cylinder and allowed to remain there for about half an hour till the clothes are ready to be removed. Thus the operation of these presses occurs about once every half hour during the entire day.

They are also using high-pressure air in their boilers as a *smoke consumer*. This air is injected by jets into the smoke over the top of the fire, the idea being that the mixture of air and fine particles of coal form a combustible mixture which burns far into the tubes, causes less deposit in the latter, increases the steaming power of the boiler, and allows the temperature of the fire box to be lower, for the same boiler performance and fuel consumption, besides almost entirely eliminating the smoke. Their high-pressure is supposed to be 50 pounds, but when operating the smoke consumer it often drops to 35 pounds.

Their air plant consists of one 9½x11x10 inch air compressor with plain air cylinder, controlled by a governor set at 55 lbs., and mounted on uprights between floor and ceiling of their power plant in the basement. The boiler pressure is 90 lbs. The air suction is piped to an open basement under an extension of their plant, the length of suction pipe being about 12 or 15 feet. They have 100 feet of discharge pipe between the pump and storage reservoirs. The latter are two 26½x54 coupled in series with a reducing valve between them, so that one reservoir is high pressure and the other low pressure. The two air lines are taken rrom the respective high and low pressure reservoirs.

With the entire plant operating, except the presses (including smoke consumer), the compressor made about 28 cubic feet of free air per minute. Without the smoke consumer, it made about half that amount.

Another use for compressed air, not used in either of the above mentioned laundries, but installed in some others, is the mist and spray dampeners. The pressure required is only a few ounces. The use of this dampener is not continuous, each employe starting and stopping it for his own use, and as the dampening process is very quickly performed, the average air consumption is very small.

Compressed air is so useful for a multitude of other purposes, that it bids fair before long to become a recognized necessity for all well equipped laundries.—*National Laundry Journal.*

MELTING SNOW IN RAILROAD YARDS

One of the most serious winter tasks in railroad yards in winter is the keeping of the switches free from ice and in operative condition. Snow and sleet storms; water from leaking locomotive tanks, overflow from injector pipes and engines, drips from car heating, and water from train lavatories and kitchens, emptied into the switch and interlocking mechanisms are constantly throwing them out of service. Various schemes have been proposed and different arrangements have been tried, nearly all necessitating extensive and costly installation under and around the switch apparatus and after all being liable to give out when their services were most needed.

During the past year a new system of snow melting has been used at several of the large terminals, and we find an intelligent sketch of

it in a paper by Mr. James S Lang, read before the Railway Signal Association of Chicago. The praticability of the system has been demonstrated during the past three winters at one of the busiest terminals in the country, with the result that delays due to snow and sleet storms have been almost entirely eliminated.

An extremely low cost, both of installation and operation, is possible on account of the small amount of apparatus required in comparison to the number of switches protected. Instead of requiring piping or permanent apparatus for each switch, several switches are handled with no more apparatus than is necessary for one, and nothing that might in any way interfere with either operation or the repair of switch or track is used. Even complicated and busy yards may be taken care of by the regular track and interlocking forces without any extra help whatever. The savative of the ties. At night the light given off by the flame by rendering the forms of men visible, lessens the danger of personal injury.

One of the first steps in installing this system is necessarily the installation of sufficient storage capacity for the liquid. This would vary in proportion to the number of switches which it was desired to keep operative, the average severity of the storms and the facilities for obtaining the fluid. The fluid is obtainable in the open market at from three to five cents a gallon, and may be obtained free of cost by railroads operating their own Pintsch gas plant.

At one plant, where this system has been in use, the tank, having a capacity of several thousand gallons, was connected with the compressed air used by the interlocking system, and when about 10 lbs. air pressure was admitted to the tank, the liquid was forced,

Hand Cleaning Yard Switches.

150 extra men, 24 hours each, 360 hours, @ 20c.	$720.00	
33 regular men (including foremen), 30 hours each.	181.70	
Meals: 150 men, 3 meals each, 450 meals; 33 regular men, 3 meals each, 99 meals; or a total of 549 meals, @ 20c.	109.80	
		$1,011.50

Using Snow Melting System.

No meals (men enabled to leave for meals).		
No extra men.		
Regular men, 20 hours each (duration of storm 24 hours, absent 4 hours for meals)	$121.80	
Hydrocarbon, 1,900 gallons @ 4c.	76.00	
Incidental charges, and rentals, which might regularly be charged to storm in question	66.60	
		$264.40
Saving effected in one storm		$747.10

COMPARISON OF COSTS OF CLEANING SWITCHES.

ing in operation by this method as compared with the usual method of hand cleaning will pay the entire cost of installation in a single large storm.

The melting of the snow or ice is effected by applying to it a flaming fluid which continues to burn while in the snow, melting and finally evaporating the greater portion of it. The character of the fluid is such that the flame is easily maintained regardless of high winds or drifting snow.

The fluid is applied by the regular track force by means of a safety distributing can, and the height and extent of the flame can be regulated with ease. No injury to track results, as the temperature of the rails is not raised to the usual summer heat, while the fluid, being a hydrocarbon, acts as a preservthrough buried piping, to the several drawing outlets, located in various parts of the yard.

The storage arrangements may therefore vary from only a single 200 gallon iron drum, elevated upon blocking, where only a few switches are to be looked after, to a tank of several thousand gallon capacity feeding various lines of underground piping, in yards where the number of switches is large and the territory extensive, or where it is inconvenient or dangerous to cross tracks; or where there is no convenient nearby location for a tank.

The supply stations for the distribution of the fluid are provided with safety self-closing faucets, and drawing gages which enable the operator to readily tell, when the cans are

being filled, how much fluid they contain, and how much is being used.

The table gives data derived from experience in a storm occurring during the past winter at one of the busiest yards. In comparison with the results obtained by the hydrocarbon system is given a careful estimate of corresponding cost of hand cleaning, based upon the experience of previous years and corresponding snowfall.

This severe storm was taken care of without a single delay chargeable to snow, and switch failures were less than one per cent. of the usual number.

LIQUID AIR AND THE PRODUCTION OF OXYGEN

The voluminous judgment of Lord Justice Fletcher Moulton in the case of the British Liquid Air Company *vs.* the British Oxygen Company, Limited, comprised among other things, a dissertation on the history and practice of the production of oxygen from the air by mechanical means, which was summarized in a recent issue of the *Engineers,* London, and which summary is here presented in a more condensed form.

The phrases "partial co-operation," "fractional evaporation" and "fractional distillation," accurring frequently in the evidence and argument have first to be defined. Evaporation is, of course, the change of liquid into vapor; that is from the liquid into the gaseous form. Distillation, etymologically, is the separation or recalling of the liquid from the form of vapour to its original state by means of condensation. By usage, however, distillation has come to mean the whole operation of evaporation and subsequent condensation. When the liquid operated on is a mixture of components differing in volatility, the more volatile component will be the more esaily evaporated, and the resulting vapor will be richer in it than was the original mixture. If, then, this vapor be condensed, the resulting liquid will still be a mixture of the two original components, but will be much richer in the more volatile component than the initial mixture. This operation is known as "fractional distillation," and it is affected by "fractional evaporation" followed by condensation. It is evident, however, that the original liquid gets weaker and weaker in the more volatile component as the operation is continued, and if it is desired to get as strong a resulting mixture as possible the operation must not be pushed too far, or, in other words, the original liquid must only be partially evaporated. "Partial evaporation," therefore, is practically synonymous with "fractional evaporation" when it is used in connection with the process of distillation.

In the progress of the case upon which this judgment was rendered, considerable confusion had arisen through the use of the word "pure" as applied to gases separated by the various types of apparatus under consideration. This was not to be wondered at. The apparatuses in question were producing on a commercial scale a product which was sufficiently free from admixture to be practically and commercially equivalent to the chemically pure article. Of course, for scientific reasons, absolute purity could not be looked for with any such processes as those involved, and from the evidence it appeared that 98 per cent. was the purity which could be obtained by careful working, and this should be borne in mind whenever the word "pure" is applied to such products.

The subject matter of the inventions with which the case deals are of the greatest interest. They relate to the first commercial application of the scientific advance that has been made during the last quarter of a century in obtaining extreme cold. The names which occurred in the evidence were of those who were the pioneers in this advance—Raoul Pictet, Cailletet, Dewar, and Linde. The first two shared the honour of being the first to liquefy air; Dewar was the first to obtain liquid air in substantial quantities, and was the first to liquefy hydrogen; Linde, by his inventions of 1895 and 1902, had made what seemed to be the two most important contributions to the practical utilization of these low temperatures. It had been long known that when compressed air was used to do external work there was a great fall in temperature. It had also been shown by Sir William Thomson and Mr. Joule that if compressed air were allowed to expand without doing external work there was some fall of temperature, due to the fact that internal work must be done in such expansion. Linde was the first to recognise that this cooling effect be increased very rapidly as the temperature fell, and he used it to make a most

practical and effective air-liquefying apparatus. Air was compressed to a very considerable pressure. This raised its temperature. It was then cooled by letting it flow through coils immersed in water. It was then passed through the inner pipe of a coil of double metal piping, that is, a coil constructed of a pipe which itself contained an inner metal pipe having the same central line. This double pipe at its further end communicated with a closed vessel, the end of the outer pipe opening freely into it, but the end of the inner pipe being provided with a stop-cock to regulate the rate of escape of the compressed air into the closed vessel. The other end of the outer pipe communicated freely with the atmosphere. On its admission into the closed vessel the compressed air expanded and fell in temperature. As it passed away to the atmosphere through the outer tube it cooled the air in the inner tube. This cooling of the compressed air caused the cooling effect of its expansion to become greater. The refrigerating effect continued to increase until at length the cold became so intense that a portion of the incoming air liquefied and collected in the vessel. He thus obtained a continuous process for producing intense cold, and thereby liquefying gases by "countercurrent-interchangers"—as the arrangement is called—which process is of great practical value.

Linde, however, did not only aim at the production of liquid air, for which there is no great commercial demand. What he did hope to do was to obtain substantially pure oxygen from the liquid so produced. In this he relied on the fact that nitrogen is more volatile than oxygen, and hoped that it would volatilise more quickly than the oxygen, till practically all of it was gone and only oxygen remained. When Linde took out his 1895 patent he overrated the efficiency of this method. It is quite practicable to get a richness of, say, 60 per cent. of oxygen in this way, but when the process is carried further so much oxygen itself comes off that by the time the required purity is attained so little "pure" oxygen remains as to render the process useless for commercial purposes. His 1902 patent, however, which has since been acquired by the defendants, enabled him to manufacture successfully and commercially substantially pure oxygen.

Fig. 1 is from the Linde patent of 1902. Compressed air cooled by counter-current-interchangers is conducted to the lower chamber of the vessels. This lower chamber is separated from the upper part of the vessel by a tube plate forming the support for numerous metal tubes, which are closed at their upper ends—so that there is a flow of air into but not through them—and which project into the upper portion of the vessel *s*. This upper portion is full of a liquid which contains about 98 per cent. oxygen and 2 per cent. nitrogen. This liquid is practically at atmospheric pressure because the vessel is open at the top and the space in which it is enclosed is in free communication with the atmosphere through the outer coil of the counter-current interchanger, the coils of which are arranged to form close walls round the space in which the vessel *s* is situated, so that it is insulated from the air and surrounding objects, and can be kept at a sufficiently low temperature to permit the mixture in it to remain liquid.

The action of the apparatus is as follows:—The compressed and cooled air enters, as has been said, into bottom part of the vessel *s*, and in doing so fills the tubes above referred to. These being surrounded by liquid oxygen at atmospheric pressure, a temperature is produced which is sufficiently low to liquefy the air in them, and the resulting liquid falls into the receptacle below the tubes. As time goes on such a quantity of liquid collects that it is forced by the pressure of the incoming air up the pipe on the right-hand side, which is provided with a stop-cock, and which communicates with the top of *r*. This is what is known as a rectifying column, and it contains a quantity of glass balls. The liquefied air, which, it will be remembered, has already had its temperature reducted to that of boiling oxygen in the bottom of the vessel *s*, as it is delivered at the top of the rectifying column *r*, suddenly has its pressure reduced to that of the atmosphere. It is accordingly very much cooled, and in this condition it falls down among the glass balls, up through which there is continually rising the vapor of the practically pure oxygen contained in the upper part of the vessel *s*. The consequence is that the comparatively warm oxygen vapors, which start at a temperature of about 91 deg. absolute, meet the

cold liquid air, which starts at a temperature of about 78 deg. absolute, and as the two meet among the glass balls "an infinitude of small partial evaporations take place, in all of which the more volatile element nitrogen has the preference and rises as a gas, and the less volatile oxygen condenses and falls as a liquid." The consequence is that

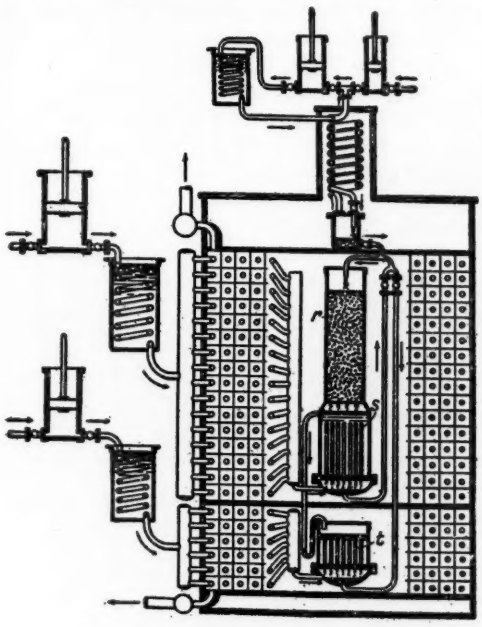


FIG. I.

most of the nitrogen escapes, carrying with it a small proportion of oxygen, and by the time the oxygen reaches the vessel *s* it has got rid of all but about 2 per cent. of its nitrogen. As a result the strength of the liquid oxygen in *s*, though the amount of the liquid is continually increasing, remains at about 98 per cent. when the apparatus is in full work. The vessel *s* overflows into the vessel *t*, and the gas evaporated from that vessel is commercial oxygen.

When dealing with the novelty of employing a rectifying column in the process of separating oxygen from a mixture of oxygen and nitrogen, Lord Justice Moulton thought it was not a mere transplanting an old device to another soil more or less analogous, but that there had to be inventive preparation of that soil before successful transplantation could take place at all. His reasons for this view were given at some length, but we need only say that in his opinion Linde had made the entering stream of compressed and cooled air play the double *rôle* of the boiler fire and cold wash in the Coffey still. He had done this by availing himself of the intense volatility of the materials with which he was dealing, which enabled him to make them change their state by variations of both pressure and temperature. So far from his success being due to the new circumstances being analogous to those of the Coffey still, he—Lord Justice Moulton—considered that Linde's invention was based on their being different. He had not succeeded not only in spite of these differences, but because of them. To say that no invention was required to achieve this was to his—the judge's—mind absurd.

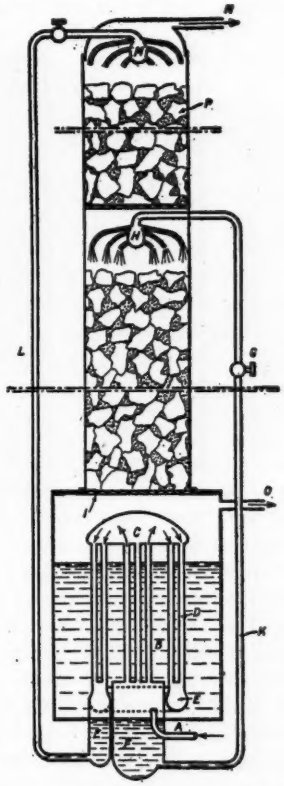


FIG. II.

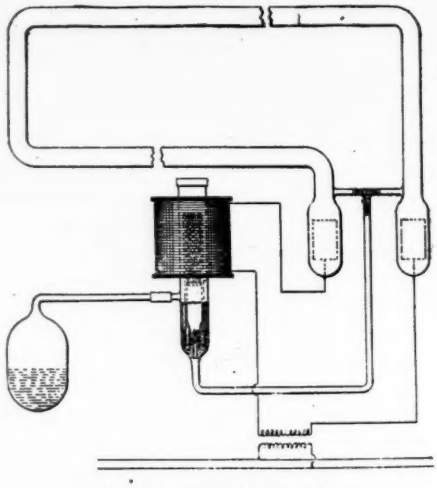
The defendant's machine described above was then compared with that of the plaintiff, sketched in Fig. 2. The compressed air here enters at *a*, after having been cooled by the emergent gases in counter-current interchangers, as in Linde's invention. These in-

terchangers are not shown in the engraving, but are admitted to be essential to the working of the machine. The plaintiffs thus make use of the first three essentials described in Linde's patent. The cooled and compressed air is led into the lower chamber of a vessel K, corresponding to the vessel *s* in Linde's apparatus both in position and function. This lower chamber is separated from the upper part of the vessel by a tube plate forming the support for numerous metal tubes which project into the upper chamber of the vessel E. There is thus a flow into these tubes but not through them. The upper portion of K is an open vessel which contains practically pure oxygen at atmospheric pressure, and his oxygen is evaporated by the latent heat of the compressed air which passes through the walls of the tubes immersed in the liquid. All this is precisely the same as in Linde's apparatus. The only peculiarity to be found in the plaintiff's mode of performing this operation as contrasted with that shown in Linde's specification is that the tubes in the plaintiff's machine are diagrammatically in the form of an inverted U and are not straight. This change in the shape of the tubes does not affect the condensation which goes on therein, but it affects the collection of the condensed liquid. In the defendants' apparatus the whole of the condensed liquid runs back into the receptacle beneath the entrance to the tubes, and collects there. As shown in Fig. 2—the plaintiff's apparatus—the condensed liquid that is formed in the first half of each tube, that is, in the ascending leg of the inverted U, falls back into the receptacle F beneath the entrance to the tubes, but that which is formed in the descending leg of the U falls to the further end of the tube into a corresponding receptacle placed there to receive it, and which constitutes the termination of the tube, so as to make it a closed tube so far as the passage of the entering air is concerned. Both the liquids in E and F contain mixtures of oxygen and nitrogen, but of varying strengths, that in F being the stronger as regards percentage of oxygen.

Having thus procured their liquefied mixtures, the plaintiffs proceed to separate the oxygen from them. For this purpose they use a rectifier just as Linde does. The two mixtures of nitrogen and oxygen are forced by the air pressure to different elevations in this rectifier, the weaker, as might be expected, being taken to the higher level. This is the only difference, his Lordship explained, and he stigmatised it as "a mere commonplace in the use of rectifying apparatus." In his opinion, therefore, the plaintiffs' machine is a clear infringement of the defendants' patent, for it operates by possessing the three essentials of Linde's invention, set out as such in his specification:—(1) It cools the air to be condensed by causing it to flow in the contrary direction to that of the evaporation products; (2) it then causes the same to transmit its heat to the evaporating liquid; and (3) it then causes the vapors produced in the distilling apparatus to flow upwards through the liquid air flowing downwards in a stratified manner. "Every word of this description," he said, "applies to the plaintiff's machine just as aptly and just as compietely as it does to that shown and claimed in the defendants' patent.

MINUTE VACUUM ADJUSTMENT

In vacuum apparatus, after continued pass of the electrical energy and the heating of the glass walls the vacuum is observed to increase, and, as a certain condition of partial



MINUTE VACUUM ADJUSTMENT.

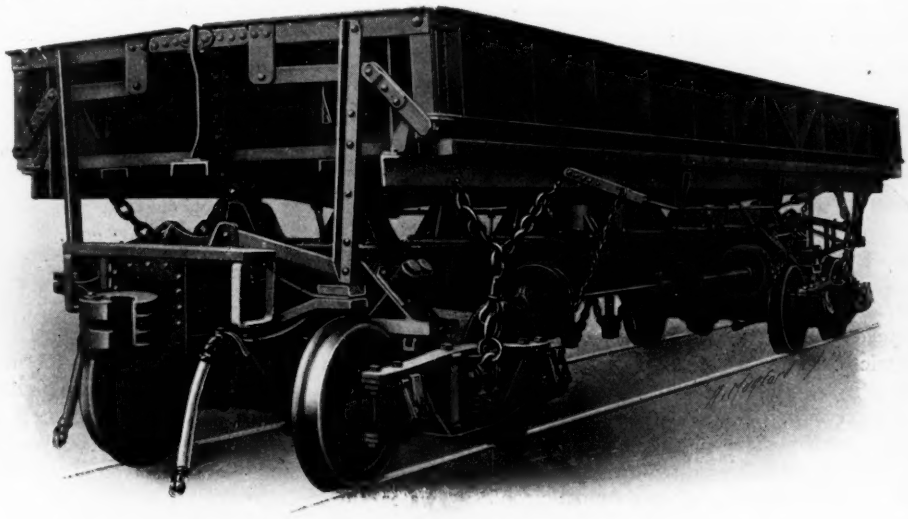
vacuum is necessary, if the exhaustion ranges too high the required impressed voltage effects a passage of electricity through the extremely rarefied gases and becomes so high as to be inefficient. By the invention of Daniel McFarlane Moore any desired gas is auto-

matically introduced into the tube. The arrangement of the inlet valve is shown in the cut which we reproduce from *The Western Electrician*. The apparatus consists of a storage tank or receiver for a readitly vaporizable liquid connected to the vacuum tube through the valve which is electromagnectically controlled by the winding in series with the main lamp current. The branch tube leading into the lamp is shown filled with sand to prevent short-circuiting of the high-tension discharge.

The valve itself contains a pool of mercury which normally seals the imgress opening through the displacement due to the presence of a plunger. As the current in the tube increases the magnet winding lifts its armature, withdrawing the displacer and allowing the mercury to drop away from the inlet opening, thus admitting the gas which is given off by the liquid in the container. A minute quantity only flows before the pressure rises so as to cause the magnet to close the valve and stop the flow. A reduction of tension in the flask and communicating spaces up to the regulating valve below that which is necessary to practically maintain the contents in the liquid or solid condition will permit the evolution of more gas or vapor, which will, therefore, be ready at a higher pressure in the chamber than in the tubes, so that a feed of gas will take place whenever the communication is opened by the gas-regulating valve.

AN AIR DUMP CAR

The half tone shows a new 20 yard air dump car built by the William J. Oliver Mfg. Co., Knoxville, Tenn. This car is strongly built throughout to stand the severe service of handling earth and rock. The draft sills are built up of two steel channel beams, with separators, cover plates, etc. The bottom is of 3 inch oak reinforced by a 10 inch steel center channel the full length of the body, also by two intermediate sills made of 8 inch channel beams and by two outer edge angle braces. The car is trussed by two 1½ inch rods with turn-buckles. The center sill is pivoted to rim hinges on the draft sills. The steel plate doors are reinforced longitudinally at the top and bottom and also vertically by angles.



NEW OLIVER DUMP CAR.

The car has a long truck base distributing the weight over a large area of false work, and in dumping all material goes clear of the trucks and oil boxes. There is a toggle door raising lever arrangement and as the car is dumped the lower edge of the door is thrown upward and away from the contents of the car, thereby minimizing the liability of material striking against and wedging or springing the door. The same toggle device also locks the doors securely when the car body is in the horizontal or load carrying position.

Under the car are two air pipe lines; the air brake pipe and the air dump pipe. At each end of the car is a three way cock from

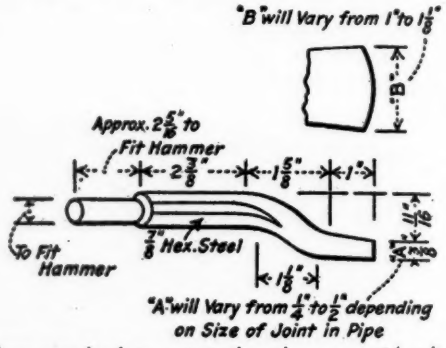
which there are two branch pipes connected to the two dump cylinders, so that the car can be dumped from either end. In the operation of dumping air is turned by the three way cock into the air cylinder operating the longitudinal shaft on the designated side. This causes a downward movement of the air dump piston to the rod of which is attached a sheave which pressing upon a chain causes the longitudinal shaft to turn and the turning of this shaft causes a downward pull of the dump chains which are attached to one of the sheaves on the end of the shaft and at the other end to the body of the car thereby bringing the body of the car to the dumping position. To bring the car body to the horizontal position again air is turned into the cylinder on the other side of the car. When the car body is being tipped the pistons travel in opposite directions.

The car is equipped with the Oliver patent steel non-clogging coupler. It has the standard M. C. B. contour, with solid top and open bottom, so that if earth should get inside of the coupler casting it would not lodge there and interfere with the operation.

A PNEUMATIC TOOL FOR CAULKING PIPE

Mr. A. E. Walden, Superintendent and Chief Engineer of the Baltimore County Water and Electric Company, contributes to *Engineering News,* from which we reproduce it, the following account of his experiences in laying a long line of water pipe, the narrative having to do principally with the caulking of the joints by a specially adapted pneumatic tool.

In 1906 the Baltimore County Water and Electric Co. started to lay about 25 miles of 12, 10 and 8-in. pipe cross country to take care of a section that was supplied by deep wells which had given every evidence of failing entirely and prevented taking on additional consumers, and giving satisfactory service to consumers already connected. It was soon found that expert and rapid caulkers could not be secured and a portable compressed air plant for caulking, cutting and drilling was purchased and mounted on a truck, which proved a success in every respect, though some trouble was experienced with the gas engine. It was found possible to calk a 12-in. pipe satisfactory for 250 lbs. working pressure in 2½ minutes, the average of all joints being between three and five minutes. The joints were more satisfactory and were tight in every respect. The average actual time for hand calking on this size pipe was 30 minutes, but the all-day average was 45 minutes. At one time two men, with the air hammers, calked between 8 a. m. and 5 p. m. 76 lengths of 12-in. pipe out of a total of 87 pieces laid and leaded. This work was done in cold weather, which made it difficult to get the best results. This line is operating under pressure of from 100 to 250 lbs. per sq. in., depending on the elevation, and so far there has not been a joint leak where the air tool was used. The



time required to cut 12-in. pipe was 2½ minutes. The portable plant was made up as follows:

A 6-HP. gasoline engine was belted to a small duplex air compressor capable of maintaining 70 to 80 lbs. air pressure when deliving 32 to 35 cu. ft. of air per minute, with storage and cooling tank and a small centrifugal circulating pump for circulating the water through the jacket. The engine was of the single cylinder vertical type, but it was found that a two-cylinder engine would have been better, and it is possible that one of the small, air-cooled, multi-cylinder, marine engines would have given the best results. The equipment was mounted on trucks, and provided with two lengths, of 150 ft. each, of ½-in. air hose connected to a storage tank at two different points so that it would only be necessary to move the machine once in every 300 ft. An air-hammer drill was provided operated from the same equipment capable of drilling up to 4-ft. holes. In the niggerhead formation it was possible to drill at the rate of 2 ins. per minute.

Two sizes of hammers for calking were purchased, one 3-in. and one 2-in. The 3-in.

hammer was a success, as the shorter-stroke hammer jarred the operators' wrists so that they could not operate steadily. The proper shape calking tools could not be secured from the hammer manufacturers so that it became necessary to have them made up locally. These tools are shown in the accompanying figures. The cost of the entire equipment ready to operate was $665, including engine and truck, all tools, drills, hammers, etc. The usual antipathy of men toward labor saving devices was encountered but the results obtained demonstrated the possibilities of the equipment to do even better work than it did here. The same truck is now to be equipped with a small centrifugal pump for pumping out trenches, etc., and will thus make a very compact outfit. It was found that the construction of the hammer could be improved by providing a spring clip that would snap over a collar on the tool to allow of the tool turning easily in the socket, but so constructed that it would prevent jumping out when starting the joint. In calking where a joint "is poured" if the lead slug is driven in and swedged off (not cut off) with the tool no leaks will occur at a joint calked with the air hammer, and it is possible to drive the joint hard enough to crack the bell.

LOCAL WELDING IN RAILWAY SHOP WORK

The following occurs in a valuable series of articles by Charles R. King, upon European Locomotive Work in recent issues of *The Engineering Magazine*.

The new processes for welding have been of the greatest utility for the work of railway shops, for they permit of the metal being fused *in situ* without having to dismount the parts to be repaired. Even a broken bridge in the orifices of a valve-chest liner can be sometimes "touched" with the flame and the liner then rebored in place. In the work of new constructions these welding processes are largely employed. At the La Chapelle (Paris) shops of the Nord Railway the oxyhydric process is in use for welding all thin plates not subject to special working strains. Boiler flues are pieced together and frame plates are welded or soldered, after being fractured in service. For joining the clothing plates of boiler or cylinders—which require to be hermetic when no non-conductor is used for lagging the boiler—it is especially serviceable. A length of 1 metre of 1-millimetre thick plate is welded in 10 minutes, consuming 20 litres of oxygen and 100 litres of hydrogen and costing, together, 14 centimes=barely 3 cents; one metre of 2-millimetre plate is soldered in 15 minutes, consuming 60 litres oxygen and 280 litres hydrogen. The proportion of hydrogen is much above the theoretical value in order to avoid oxidation. Frame plates or parts attached, are repaired with a consumption of gas differing widely in proportion to the importance and difficulty of the operation. For instance, suppose a crack 5 inches long in the angle of hornplates or axle-box guides ("pedestals"), the depth being 1¼ inches. The metal to be run into the cavities, that machined inside and outside to half-depth, calls for an expenditure of 1,500 litres of oxygen and 8,800 litres of hydrogen, costing 11.39 francs, say $2.28. The removal of the plant, its installation, the welding, and the return of the plant, takes the smith and his help 2 hours, costing 2.45 francs, so that the whole repair comes to 13.84 francs.

The process is also employed in the construction and repair of steel and iron pipes, of ash-pans, locomotive footplates, and for all kinds of repairs where the flaws are superficial and compromise neither strength nor safety.

The outsider, in watching the process, sees the operator wearing dark spectacles holding the burner against a 1¼-inch frame plate. The flame first blisters superficially; the iron then gradually becomes a blotchy red, losing color directly the flame is moved away, then reddening through the whole depth of the metal, and finally becomes white and attains the point of fusion, when the soft iron rod to fill the cavity is introduced and fuses with the neighboring metal of the plate being welded. With boiler flues the two coned and hollowed ends of the tubes are lightly butted together while resting on a X-trestle, and the operator touches the joint with the flame forming a series of little fused points, turning the tube slightly with each touch of the flame. Each operator welds 120 flues daily, or an average of 5 minutes per tube, the cost in gas for each 10 tubes being 100 litres oxygen and 650 litres hydrogen, costing, together, 81 centimes or 16 cents. The saving as compared with the old system of brazing amounts to 40 centimes (8 sous or 8 cents) per tube, or enough to pay for the gas required to weld 5 tubes.

An assistant removes the welded tubes and passes one extremity of the flue through a hole in a block, leaning on the other extremity, turning the tube slightly at each pressure. The tube, according to the foreman, never breaks at the joint but gives way at any other part if the tube is tested to destruction.

Summing up the price of shop work in connection with this form of welding, each tube costs 32 centimes, or 6½ cents, for labor; that is, cleaning and cutting down old tubes, sawing off and chamfering the new ends for the firebox extremities, welding, straightening; tests in the block and at the hydraulic press, and trials at the store reception. The gas costs 0.81 centimes per tube, consequently each tube thus welded costs, altogether, 40.1 centimes or 8 sous or cents.

The saving by this process for welding ribbed tubes of the Serve pattern is even greater—that is 13 sous or cents per tube. The ends of the tubes are hollowed and coned as usual, the lip on the hollowed end furnishing the metal for the fusion of the joint. Each tube-weld necessitates 60 litres oxygen and 243 litres hydrogen, together worth 37 centimes or 7½ cents. Each installation turns out 60 welded tubes per day or an average of 10 minutes for each ribbed tube, for which 4 sous or cents per tube is allowed. The entire cost per tube amounts to 25 sous or cents—one shilling—in including cleaning, selecting, and cutting down of tubes, removal of ribs at the extremities, sawing off the new end, chamfering the joints and, at the same time, removing the ribs near to the weld, welding, straightening and testing.

The two kinds of gases are delivered in steel cylinders of 47 litres capacity and at a pressure of 150 kilogrammes per square centimetre. Reduced to atmospheric pressure, each cylinder therefore contains about 7 cubic metres of gas for which 16 sous or cents is paid to the "Société L'Oxhydrique Française" per cubic metre of hydrogen and 58 sous per cubic metre of oxygen. For thin metal up to 3 millimetres thickness this process is as quite as economical as the oxyactelenic process of welding, but beyond that thickness the latter is the more economical. By reason of its less intense whiteness the glare of the oxyhydric flame is said to fatigue less the eyes of the operatives.

A NATURAL AGGREGATION OF RARE MINERALS

F. L. Hess, of the United States Geological Survey, in a report just published forming a part of an advance chapter from the Geological Survey's Bulletin No. 340, calls attention to perhaps the most remarkable natural mound in the United States. It is in the middle of the "Llano region," an "island" of pre-Cambrian rocks almost in the geographical center of Texas, known as Baringer Hill and celebrated for its content of what geologists term "rare earth metal minerals." In a short description of this hill, which is formed by a "dike" and is only about 40 feet high and about 100 by 200 feet in lateral dimensions, is given a list of about two dozen minerals found in this small area, among them a number of radioactive materials and others of great and increasing practical importance. Among the rare-earth minerals at Baringer Hill are fergusonite, gadolinite, polycrase, yttrialite, and cyrtolite.

The economic interest in these minerals is due to the incandescence of their oxides on being heated. This property makes them available for use as glowers in gas and electric lamps. Tnoria, beryllia, yttria, and zirconia are the most useful minerals employed for this purpose. Until the discovery of the deposits at Baringer Hill it was practically impossible to get sufficient yttria bearing minerals to manufacture mantles for electric glow lamps; but fergusonite and gadolinite, with lesser amounts of cyrtolite and other minerals containing yttria, occur here in quantities large enough to meet the demand. The Nernst Lamp company owns this valuable deposit, but its needs require only the occasional working of the mine. After enough yttria minerals are obtained to supply its wants for several months the mine is closed. Only a few hundred pounds a year are extracted.

The geologic island in which Baringer Hill is located is interspersed with other mounds and dikes of similar appearance, which have been considerably prospected, but without much success. Mr. Hess states that as these rare-earth minerals constitute only a small fraction of 1 per cent. of the total mass, commercially large amounts may exist in a dike and not be exposed at the outcrop; but suggests that cracks that generally surround the nuclei of the minerals may be utilized in prospecting.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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COMPRESSED AIR CONSISTENCY

A maker should certainly appreciate and employ to his own advantage the goods or appliances which he is urging others to buy; yet there are those who do not. This general topic having been opened recently by our esteemed contemporary *Machinery* to whom a correspondent writes as follows:

"The writer can call to mind several instances where manufactuers show their inconsistency in this respect. This can be best illustrated by a specific case, referring to a concern capitalized at $3,500,000, and manufacturing steam engines, air compressors, water in-takes operated by compressed air, air-lift systems, centrifugal pumps of all sizes, and several other kinds of machines for pumping purposes. This firm has a machine shop, foundry, wood shop, pattern shop, blacksmith shop, and ware-house—all modern buildings. These shops all receive their power from a central power plant equipped with a Corliss engine and a direct current generator. The machine shop is equipped with an electric traveling crane, while the foundry and blacksmith shop have jib cranes operated by hand. The concern has spent thousands of dollars for jigs in order to lower the cost of production. The shops are lighted by electricity, and the clock system of time keeping has been installed. Besides this, there is an excellently arranged stock department.

"Contrasted with this is the equipment of the foundry. Since this firm manufactures air compressors, one would naturally expect to see some pneumatic tools in operation, especially in the foundry; but no, all the riddling and chipping is done by hand. Pieces that are too large to put in the rattler are brushed and cleaned up by hand. And, to cap the climax, instead of using one of the firm's own air-lift pumps for the water system, there is an old power pump jack that keeps the water well oiled, and breaks down regularly once every two weeks.

"Now this firm's trade in air compressors has fallen off considerably in the last two years, due, it is claimed, to the competition in that line. It is the writer's opinion that if this firm would practice what it preaches, it would be able to get in on the ground floor with the other fellow. The use of air hammers, air chisels, air brushes, sand blasts, emery wheels operated by air, air drills, rid-

dles operated by air, and air lifts, would not only cheapen the labor cost, but the practical application of compressed air to the work of the machine shop, foundry, blacksmith shop, etc., would be an object lesson to the intending purchaser that would tend to hasten his decision."

There will be opinions as to the propriety of, and as to the good taste displayed in, such revelations as this. We have ours, and we have taken pains not to know the identity of the establishment above referred to. We do known, however, that there are establishments, capitalized at more than $300,000, to which these remarks do not apply. We have in mind one establishment, which builds air compressors and other things, where a supply of compressed air at two different pressures is carried throughout the works by many miles of piping, and where all the devices spoken of above as conspicuous by their absence, and many others which the alert looking out for economy and conveniences have suggested, are in constant employment. This everyday familiarity of all hands with compressed air practice constantly leads to new applications and to the originating of new devices which ultimately are offered to customers. Not only are the possibilities of compressed air here appreciated and the range of its adaptability availed of, but its limitations also are understood, and nowhere is compressed air used perfunctorily. The entire establishment is electric driven, with individual motors for the larger or isolated machines and light electric driven line shafts for the smaller tools. No line shafts, belts, cables or steam pipes run out of the power house to the various buildings. The air pipes and the electric wires run side by side, their only accompaniments being the going and returning water pipes for the heating service. Such an establishment is in position to advocate intelligently and consistently compressed air practice and its own compressed air appliances.

COMPRESSED AIR PROGRESS

In the course of his classical researches into the steam engine and other prime movers, Professor Rankine showed the great theoretical advantages of the air engine, as compared with motors using a fluid such as steam, which changed its state from the gaseous to the liquid form during the development of active energy from heat. The air engine, in the forms in which he considered it, however, never became a commercial success, although some of the principles upon which his analysis of it were based enter into the operation of the modern internal-combustion engine. Nevertheless the advantages of the elasticity of air, in connection with the transmission and application of power, have acquired great mechanical and commercial importance, and the air compressor, in its latest and highest types, together with the numerous useful machines for the application of compressed air, has become an accepted manufactured product, comparable in magnitude and importance with the steam engine.

It is especially in connection with the transmission of power to certain classes of operative tools that the air compressor has found successful application. The rock drill, it is true, is often operated by steam taken directly from the boiler, but this is in cases in which the distance between the generator and the operative machine is comparatively short and the temporary nature of the work renders the losses by leakage and condensation relatively unimportant. In extensive mining work; in important tunneling operations, in the great majority of cases compressed air is employed, its use carrying with it absolute assurance against the serious loss from condensation accompanying the use of steam, together with freedom from excessive heat, annoying drip of water, and minor inconveniences well known in practice.

In the machine shop the air compressor has become an accepted element in the modern plant. Many small tools, such as portable drills, riveters, chipping tools, etc., operated by compressed air, form essential parts of the outfit, and the ability to take the tool to the work and perform minor operations directly under the hand of the skilled workman has practically given such workmen the opportunity of extending their personal skill far beyond the capacity of the hammer, chisel, and file with which they acquired it. Even in such a minor function as that of blowing away the accumulation of chips and dust beneath the cutting tool in the machine, the provision of a supply of compressed air throughout the shop has demonstrated its value, and the mere knowledge that a supply of air is "on tap," so to speak, suggests its application in many

labor-saving ways. The modern caisson system for sinking foundation is dependent upon the air compressor for its existence, whether the work be on land or under water. The great bridge and the tall building depend alike upon the possibilities of the application of compressed air for their foundations and for the mechanical riveting of their structural-steel members.

All these applications of compressed air involve the design and commercial production of the machines by which the air under pressure may be economically produced, a department of engineering which demands knowledge and experience of the highest grade, both in the principles of thermodynamics and in the fundamentals of machine design. Different conditions demand machines suited to the special service required; the compressor must be adapted to the mine, the quarry, the workshop, and the portable equipment of the contractor; in short, it must be the product of familiarity with the mechanical, operative, and commercial conditions under which it has to be used, a familiarity which comes only from the combination of trained engineering skill with long experience.—*Cassier's Magazine.*

INVESTIGATING COMPRESSED AIR LOSSES

Some rather important points were brought up by Mr. W. L. Wotherspoon at the recent meeting of the South African Association of Engineers, in discussing the Meyer and Charlton Rock Drill Tests. Mr. Wotherspoon has had a large amount of experience in making power efficiency tests and in the compilation of statistics dealing with power production on the mines. He stated that he had gone into the air power problem some time ago and had attempted to make a fairly close computation of the air power on a large number of mines. The results of his investigations showed that on one deep-level mine they could carry on work successfully with from 50-60 per cent. less power per machine shift than a neighboring and similar property, and unless it could be proved that this large varying factor is justified for ventilation purposes, it must clearly be due to uneconomical working.

The matter calls for further investigation as it means that a very large proportion of the total power costs are effected. On a large property (say 200 stamps) the air power cost usually amount to from ⅓ to ½ of the total for the mine. This may represent £2,000 a month for air power, so that if only a 10 per cent. saving could be effected, it would amount to £2,400 a year on a single mine. Again, the duties of a rock drill fitter vary a great deal. On some mines he may have fifteen machines to keep in efficient repair, while on others twice the quantity may be under his supervision, and there is no doubt but that the cost entailed through more supervision would in many instances be more than justified.—*South African Mining Journal.*

AIR WASHING AND AN AIR WASHER

The presence of dust in the air of industrial, educational and other establishments, is recognized as inimical to health and otherwise highly objectionable, and increasing attention is being given to the problem of its elimination with most encouraging results as to its practicability. This general topic is interestingly discussed in a pamphlet about to be issued by the New York Blower Company, of Chicago.

Naure's method of removing these impurities, it says, is to collect moisture on each mite of dust until, combined with others, it forms a drop of sufficient size to fall to the earth of its own weight. Millions of drops make the shower, sweeping clear the atmosphere of multi-millions of particles, absorbing gases and creating that wonderful clearness which is a sign of the resulting purity. No dry process is used by nature and no artificial process can fully succeed in which dependence is placed upon screens of any type to merely hold the dust in dry form. They cannot be automatically cleaned and require periodic attention.

The real cleaning of the atmosphere is attained by the original attraction of the moisture by the dust particles. The washing effect of the descending drops is only an incident in the process. The cloud particles permeate the space in which they are, the raindrops are relatively few and far between. An atmosphere permeated with mist, water in its most minutely divided form, must be presented to the passage of the dust laden air. Each dust particle then becomes the center of attraction for the vapor particles, it is increased in size

and weight, and the air becomes supersaturated with water held in mechanical suspension.

This excess of moisture must be created in order to grasp and hold the solid matter. But once caught these particles may be easily separated from the air and conducted away with their burden of objectionable material. Hence the extractor or eliminator, a device designed to remove the mechanically suspended particles which represent the excess of moisture. In a word supersaturation and extraction are the two essential elements in the cleansing and purification of air. The air leaving the extractor should retain no visible moisture; only that which has been absorbed and with which it is saturated. The temperature within the spray chamber should be such that when the air is heated during its subsequent passage through the main heater or flue heaters the relative humidity will be sufficiently reduced.

An accessory of the air washer is the primary tempering coil which is necessary for use during the winter season. By its means, under thermostatic control, the air entering the spray chamber is warmed to just the temperature best adapted to the action of the spray. Without such provision for pre-heating of the air the entire apparatus would become inoperative when the temperature fell below freezing.

The material of an air washer, subject as it always is to constant contact with moisture, should be uninjured by it. All metal work should be rustless. This requirement is best met by the use of brass and copper, and to a lesser degree by galvanized iron. Concrete should be substituted for wood.

NEW BOOKS

COMPRESSED AIR PLANT FOR MINES, the Production, Transmission and Use of Compressed Air, with special reference to Mine Service by Robert Peele, Mining Engineer and Professor of Mining in the School of Mines, Columbia University, New York, John Wiley & Sons, 330 pages 6 x 9 inches, 112 illustrations. Price $3.00. This is a very complete, thorough and convenient presentation of practically all accessible and up-to-date information upon the general subject of compressed air, and should be of service to all users of compressed air whether in mines, quarries, tunnels and large engineering operations in general or in specific lines of service in manufacturing and elsewhere. All the familiar types of compressors are described and illustrated, their principles of operation and details of construction are discussed as are also those of the various air operated devices. The latter portion of the book is devoted to the several lines of employment of compressed air in practical mining, the equipment and operation of typical mines being given in considerable detail. The book is handsomely and effectively illustrated and completely indexed.

HIGH PRAISE FOR A TECHNICAL BOOK

The Engineer, London, reviewing a new book on The Modern Steam Engine, by John Richardson, discourses as follows:

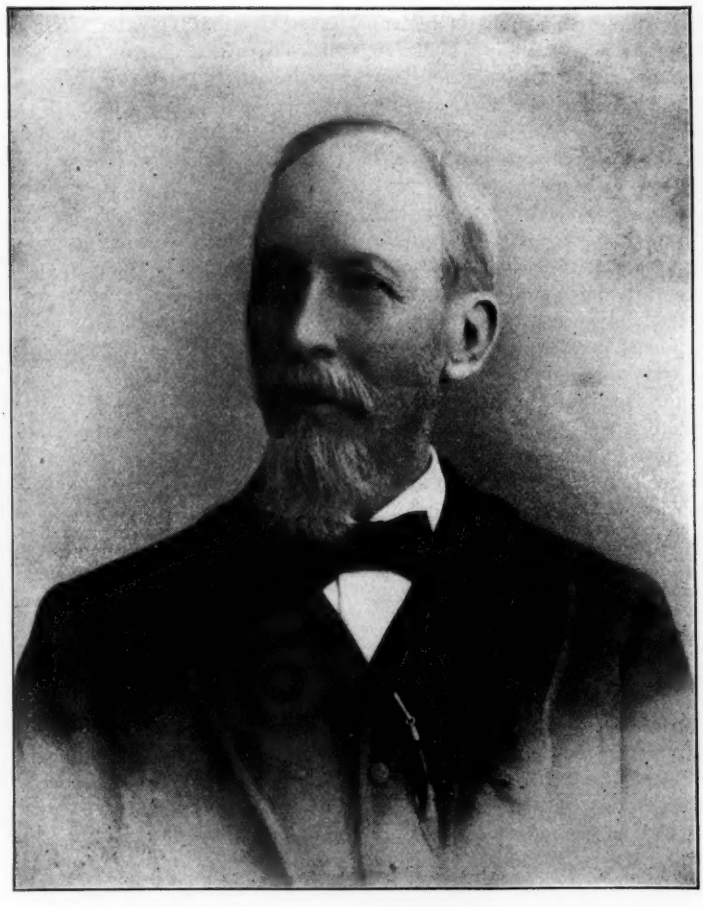
The book before us has the great fact in its favour that it has been written by a man who has during the last forty years or so superintended the design and construction of over 25,000 steam engines of from 6 to 2000 indicated horse-power. The literature of the steam engine has been narrowed in its scope, because Mr. Richardson represents a class which cannot be induced to write books. He is a notable exception, and the volume before us is also exceptional.

* * * * *

The book is essentially a practicable treatise. *It is quite delightfully free from tables and formulae.* It is a standard example of how well an engineer can get on without the personal use of the higher mathematics. In his preface our author tells us: "For those students who wish to tackle very abstruse problems, needing the use of the higher mathematics, there are many suitable books already published, and to these such students are referred. Such a course of study is for the very few; the contents of this book are for the much larger class who, starting without knowledge, want to obtain a clear but comprehensive acquaintance with the steam engine."

* * * * *

Most forms of the steam engine are dealt with, but the most interesting part of this portion of the volume is perhaps that devoted to the design of details. Here is a thoroughly practical passage: "A good designer can do more to promote morality and prevent profane swearing in an engine factory than all the ministers and clergymen in the district."



Yours Truly
Gardner D Hiscox

DEATH OF GARDNER D HISCOX

Gardner Dexter Hiscox was born at Elizabethtown, N. Y., in 1822, and died at East Orange, N. J., on Sept. 6, 1908. He was in many respects an exceptional man and deserving of more than a passing notice, but material for a consecutive narrative of his career does not seem to be accessible. Born on Lake Champlain and amid rural surroundings he had no more than the usual education obtainable in the district school and the village academy of his time, which, however, afforded facilities for practical preparation for life's activities not to be spoken lightly of even to-day. Before he was out of his teens he was teaching school and soon thereafter he engaged in

mercantile pursuits which he followed most of his active life. He was in business in Chicago when the fearful panic of 1857 occurred and brought his career to a close there. His longest consecutive business connection is understood to have been as a partner in a house in New York, manufacturing and dealing in steam and water fittings and supplies, and he became an expert and a leading authority upon steam heating, ventilation and sanitary engineering. His later years were spent in consulting and advisory engineering, in editorial work and in compiling technical books. He was connected with the Scientific American for many years and is understood to have been especially engaged there in conducting the technical question and answer department, for which he was eminently qualified. He was also a contributor to the Compressed Air Magazine from the first year of its existence. Mr. Hiscox was the victim of a serious trolley car accident some six years ago, which practically confined him to his residence for the rest of his days.

Mr. Hiscox was a man of exceptional and tireless mental activity. He perhaps had no special hobby, but he was an omnivorous collector of all available information in every line. He seemed to know much about everything and he was always glad to communicate anything that would help anybody. He was besides all else an amateur mechanic with a workshop of choice tools in which he spent many leisure hours with results of lasting excellence and value. He had an exceptionally fine microscope which he had built and a valuable collection of objects of his own preparation. He had also built a telescope and in connection with that he became incidentally the founder of the Brooklyn Astronomical Society.

The most enduring work of Mr. Hiscox is of course in his books. These, in the range of them, indicate the reach and versatility of the man. If any are disposed to speak of them as compilations rather than works of original and independent research and deduction, they must at least concede that the work he undertook to do in them was thoroughly done and they are of lasting value. The titles of his books are as follows: "Mechanical Movements," "Mechanical Appliances," "Gas, Gasoline and Oil Engines," "Twentieth Century Book of Recipes, Formulas and Processes," "Modern Steam Engineering," "Compressed Air in All Its Applications," "Hydraulic Engineering."

The Lagunitas Water Company has a plan of constructing a dam 110 feet high on the northwestern slope of Mt. Tamalpais and forming a reservoir which will impound 2,000,000,000 gallons of water to furnish a flow of 10,000,000 gallons a day to San Rafael and other towns. The Marin County Water Company, a rival, had bought up surrounding territory thinking it could make it unprofitable for the Lagunitas company to pipe a supply over the mountain. The latter company now proposes to construct a tunnel 8,000 feet long to bring water to prospective customers.

COMPRESSED AIR FOR HOISTING

Compressed-air hoisting engines should be fitted with extra large exhaust ports and pipes but should have small clearances, although the former may be dispensed with if the air to be used is reheated near the engine. A small amount of coke is all that is necessary for reheating, which prevents all danger of freezing besides effecting a decided saving. To obtain the best results, reheat the air near the place where it is to be used. The pipe for conveying the reheated air from the heater to the cylinder should be covered, as the loss of heat takes place rapidly. Live steam is a good reheater if available. Feed-water heaters give good results if the heating surface is ample and the air passage free. It has been estimated that ⅛ lb. of coke per horse-power per hour will effect a raise in temperature of 366 deg. and cause a saving of from 25 to 35 per cent.

The greatest efficiency in a compressed-air hoisting plant is obtained where a central compressing plant can be used to drive a number of different sized steam hoists located far apart, and necessitating a separate supply of water and fuel for each hoist, if there is no central heating plant. Such boilers scattered about a mine are wasteful of fuel and usually do not give an efficiency of more than 3 or 4 lb. of water for each pound of coal burned, while a central boiler plant will average an efficiency of 8 or 10 lb. per pound of coal. A compressed-air engine at the central plant is ready for instant, continuous service at full

speed. No time need be lost in working out water or quickening fires and there is no loss of steam when the hoist is stopped while the boiler fire is hot.—*Engineering & Mining Journal.*

A TUNNEL RECORD

Engineering News, from data furnished by Mr. George F. Samuel, Assistant Engineer in the Department of Public Works, gives the following account of the progress of the work upon the southwest land tunnel of the Chicago waterworks.

While the tunnel is somewhat smaller than a railway tunnel, its maximum size is a horseshoe section 14 ft. x 13 ft. 8 ins., and it is in this section that the highest record has been made. The maximum monthly progress was made in June, being in drift 21 of Section No. 3. This record was 390 ft., made by working two groups of men in two ten-hour shifts. The daily average was 13.4 ft. for 29 working days. This work was under the direction of Mr. Daniel O'Conner, as Superintendent. The maximum daily average was 16.4 ft., made by the same force on June 30. The gang for each 10-hour shift was made up as follows:

1	Foreman	1	compressor engineman
4	drillers	1	electrician and helper
4	driller helpers	1	blacksmith and helper
1	nipper	1	machinist and helper
13	muckers	1	powder man
1	cageman	1	pump man and helper
4	top men	—	
		38	Total.

The excavation is carried on by a top-heading 9 ft. high kept about 12 ft. in advance of the bench, which is shot each day. For drilling the heading there are four Ingersoll-Rand drills mounted in pairs on two columns. Each set of holes consists of 8 cut holes 9 ft. deep, 6 helper holes 7 ft. deep, and 12 rim holes 7 ft. deep. The drills are then turned over on the columns and four bench holes are drilled. About 250 lbs. of 60 per cent. gelatine dynamite are used to make an average progress of 7 ft. The rock through which the tunnel is driven is a hard limestone. The length excavated to July 31 was as follows: Section 1, 18,841 ft.; Section 2, 18,880 ft.; Section 3, 1,168 ft.

NOTES

It is announced that the Rix Compressed Air and Drill Company, of which Mr. Edward A. Rix is President and General Manager, "in response to the call of the old machinery district has been moving." The office and salesroom will hereafter be located at 371 Market Street at Fremont, and the factory at 219-221 Spear Street, San Francisco.

Illuminating gas of ordinary composition when compressed, precipitates the heavier hydrocarbons in the form of liquid or tarry products, materially reducing the incandescent effect. The peculiarity of Pintsch gas is its remaining fixed under a compression as high as ten atmospheres. It is made from high grade petroleum distillate and has an illuminating power six times that of coal gas.

A mixture which gives good results in preventing the rusting of machinery is one ounce of camphor dissolved in one pound of melted lard. Skim off the impurities and add black lead to give an iron color. Clean the machinery carefully and apply the mixture, which may be left on indefinitely, or if wiped off in 24 hours will prevent rust for some time. Polish the metal with a soft cloth after removing the mixture.

A new machine shop and foundry is being erected for the Goldschmidt Thermit Company, 90 West Street, New York. The building, 34 by 90 feet, is located in Jersey City just back of the present factory of the company and it is to be fitted up with traveling cranes and other facilities for the better handling of the extensive repair work which comes to the works, such as electric motor cases, truck frames, gear wheels, crank shafts, and in fact any wrought iron or steel sections not exceeding a ton in weight.

A sheet of iron one foot square and one inch thick weighs 40 lb., or 640 oz. Therefore a sheet of iron one foot square and $^1/_{640}$ in. thick weighs one ounce. The scale has

been arranged so that each number represents a certain number of ounces in weight, and an equal number of 64oths of an inch in thickness. The numbers range from 0000000, which weighs 320 oz. per square foot and is 0.5 in. thick, to 38, which weighs 4 oz. per square foot and is 0.00625 in. thick. An act of Congress requires that this gauge shall be used in determining the duties and taxes levied on sheet and plate iron and steel.

"Now, what is the matter with the machinery geniuses that none of them have ever invented a granite paving cutter? These fellows are certainly overlooking a bet, for such a machine could be devised without any radical new principle of mechanics being necessary. Undoubtedly, a better paving block than has ever been turned out could be made by machinery with considerable economy. There is a big bunch of grapes for the inventor who will heed this suggestion, and we know a large number of quarrymen who would like to purchase machines of this kind as fast as they can be turned out, after it is demonstrated that they can do the work."—*Rock Products.*

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D C. .

AUGUST 4.

894,813. CONCRETE-CONVEYER. JOSIAH W. BUZZELL, East Orange, N. J. and WILLIAM H. LARKIN, Jr., Worcester, Mass.

894,818. ELECTRODE FOR THE EVOLUTION OF OZONE FROM OXYGEN OR ATMOSPHERIC AIR. JOHN R. CRAIG, Jr., Glasgow, Scotland.

894,830. PROCESS OF TREATING AND HEATING AIR. GUSTAF E. HESSE, Brooklyn, N. Y.

1. The method of continuously producing a motive fluid for driving an engine, which consists in delivering air under pressure and in a continuous manner into a chamber. delivering steam continuously into said chamber to thoroughly admix with the air therein, forcing the mixed air and steam under the initial pressure applied to the air from said chamber in the form of numerous confined thin tubes, continued for a suitable distance, into a collecting chamber having an outlet therefrom, and heating said thin tubes of moving mixed air and steam from the inner sides thereof during their passage to said collecting chamber.

894,831. APPARATUS FOR TREATING AND HEATING AIR. GUSTAF E. HESSE, Brooklyn, N. Y.

894,852. BLOWING-ENGINE OR COMPRESSOR. GUSTAV B. PETSCHE, Philadelphia, Pa.

894,882. PISTON FOR AIR-PUMPS. THOMAS R. GREEN. Riverside, Cal.

894,904. AUTOMATIC SPRINKLER SYSTEM. GEORGE I. ROCKWOOD, Worcester, Mass.

895,084. AIR-COMPRESSOR OR VACUUM-PUMP. ELIE GAUCHER, Constantinople, Turkey.

895,192. APPARATUS FOR LIQUEFYING AIR. JAMES F. PLACE, Glenridge, N. J.

895,292. BLOWING-ENGINE INLET-VALVE. MARVIN A. NEELAND, Youngstown, Ohio.

895,341. GRADUATING RELEASE-VALVE. JOHN W. CLOUD, London, England.

895,349. PNEUMATIC TOOL. THOMAS DONOHOE, Avella, Pa.

895,398. SUBAQUEOUS FOUNDATION. ALBERT F. EELLS, Boston, Mass.

1. The method hereinbefore described of placing a hollow subaqueous base for piers, lighthouses and like structures, the same consisting in mounting said base, closed at the top, with its lower edge resting upon a temporary bottom, in forcing compressed air into the space within said base and bottom, and in sinking said base in place by releasing the air whereby the bottom is collapsed and the edges of the base sunk to the bottom of the water.

AUGUST 11.

895,426. PRESSURE - REDUCING VALVE. FRANK T. CABLE, Quincy, Mass.

895,438. PNEUMATIC CHUCK. CHARLES B. DELANY, Columbus, Ohio.

895,543. PNEUMATIC CAISSON. OLIVER C. EDWARDS, Jr., Troy, N. Y.

895,643. AIR-PUMP. KIRK G. JOHNSTON, New York, N. Y.

895,693. DUST ARRESTER AND SLUDGER. LOUIS T. SICKA and JOHN P. COLLINS, Butte, Mont.

1. In a rock drilling system, an air supply, an air operated rock drilling machine, a drill bit enlarged at the cutting end and operated by said drilling machine, a water tank, the top of which is flexibly connected to the air supply, a nozzle flexibly connected to the bottom of said water tank and adapted to be inserted in the drill hole behind the enlarged end of the drill bit, means for regulating the air pressure in the water tank, means for regulating the water discharged at the cutting end of the drill bit, said water tank being provided with an internaly concaved lower end for utilizing all the water in the tank.

895,735. TRAIN-PIPE COUPLING. WILLIAM G. FELKNER, Sebree, Tex.

895,750. HOT-AIR PIPE. GEORGE HARMS and CHARLES SPINDLER, Peoria, Ill.

895,798. AUTOMATIC APPARATUS FOR GAS ANALYSIS. EMIL SCHATZ, Frankfort-on-the Main, Germany.

895,877. ROCK-DRILLING DEVICE. EUGENE E. MESSMORE, Epworth, Iowa.

895,962. APPARATUS FOR COOLING AIR. CONFUCIUS CHASE, Boston, Mass.

895,984. PNEUMATIC HUB. JOHN DUCHAN, Elizabethport, N. J., and ROLAND DUCHAN and JOHANN DUCHAN, Vienna, Austria-Hungary.

895,994. AIR-CUSHION FOR HORSESHOES. JACOB H. FAWKES, Detroit, Mich.

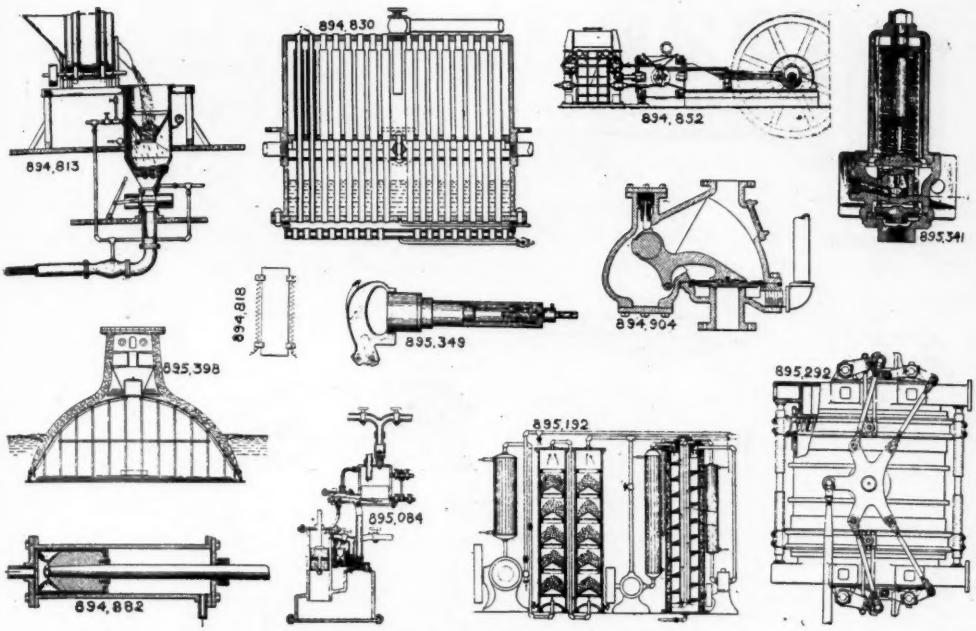
1. A device of the class described, comprising a shoe adapted to be secured to the hoof of the horse, a clamping ring fitting within the shoe, screws traversing the clamping ring and engaging the shoe, a resilient bag fitting within the clamping ring, a flexible cover fitting over the bag and having its edges inserted between the clamping ring and the shoe, an air receptacle arranged as a seat for the rider or driver, and tubes connecting the resilient bag with the receptacle.

AUGUST 18.

896,148. SPRAYING DEVICE. ADELBERT M. PHILLIPS, Le Roy, N. Y.

896,212. AIR-ACTUATED RAILWAY-FENDER. SMITH S. JOHNSON and HENRY A. THOMPSON, Seattle, Wash.

696,290. PNEUMATIC DUST - REMOVER. MILES E. FREEMAN, Bradford, Pa.



PNEUMATIC PATENTS, AUGUST 4.

A nozzle for a pneumatic carpet cleaner, having parallel walls and an apertured diaphragm within its interior, and provided with a tongue extending parallel with the walls of the nozzle and which divides the nozzle into a plurality of compartments and extends from said diaphragm outwardly.

896,365. GAS-CLEANER. ALFRED ERNST, Pittsburg, Pa.

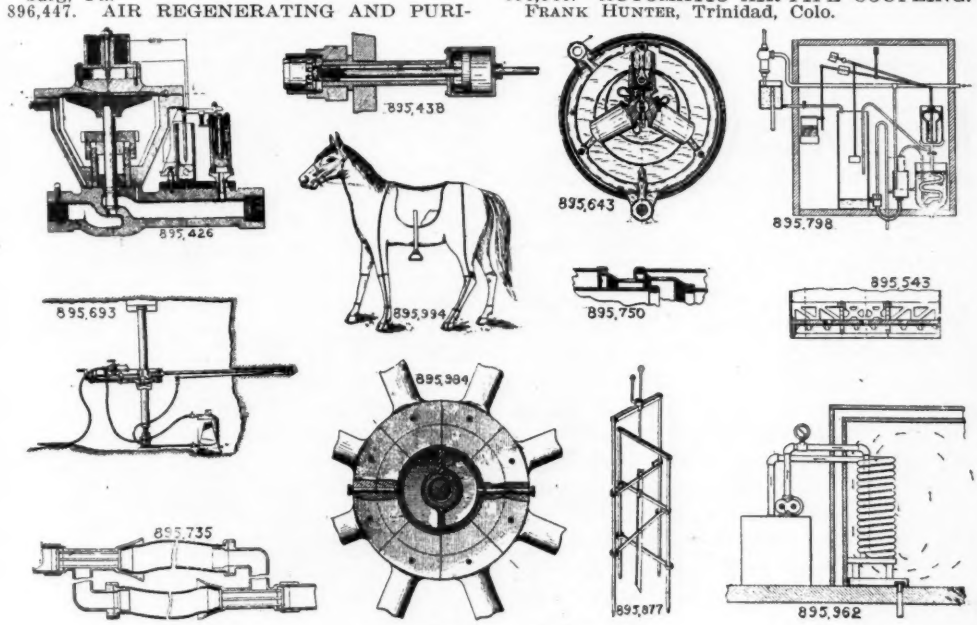
896,447. AIR REGENERATING AND PURIFYING APPARATUS. SYDNEY S. HALL and OSWALD REES, Portsmouth, England.

896,475. ROCK-DRILL. CLARK J. SMITH, Ottumwa, Iowa.

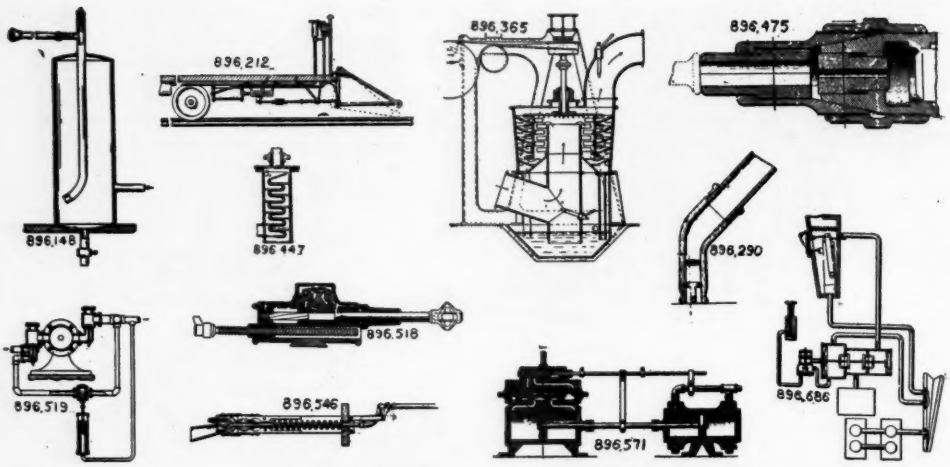
896,518. ROCK-DRILLING MACHINE. JOHN B. DAMAS and JOSPH FRANCIS, Sonora, Cal.

896,519. APPARATUS FOR MIXING GAS AND AIR. ERICH DANKELMANN, Berlin, Germany.

896,546. AUTOMATIC AIR-PIPE COUPLING. FRANK HUNTER, Trinidad, Colo.



PNEUMATIC PATENTS, AUGUST 11.



PNEUMATIC PATENTS, AUGUST 18.

896,571. COMBINED HYDRAULIC MOTOR AND AIR-COMPRESSOR. GEORGE E. OCAIN, Oak Park, Ill.

896,686. VARIABLE-TENSION EXPRESSION-BELLOWS FOR PNEUMATIC APPARATUS. GEORGE P. BRAND, New York, N. Y.

AUGUST 25.

896,777. GAS-OPERATED ROCK-DRILLING ENGINE. ROLLAND S. TROTT, Denver, Colo.

896,823. PRESSURE-MAINTAINING SYSTEM. FRANK GRAY, Chicago, Ill.; Catherine Helen Gray and Clarence Gray, executors of said Frank Gray, deceased.

896,854. TRAIN-PIPE COUPLING. ALBERT S. PARSONS, Berkeley, Cal.

896,902. TIRE-PUMP. JULIUS A. DYBLIE, Joliet, Ill.

896,933. AIR PUMP OR INFLATOR. FREDERICK S. NICKELLS, London, England.

896,956. APPARATUS FOR MIXING FLUIDS. WILLIAM F. TRAUDT, Passaic, N. J.

896,958. HIGH-PRESSURE BRAKE. WALTER V. TURNER, Wilkinsburg, Pa.

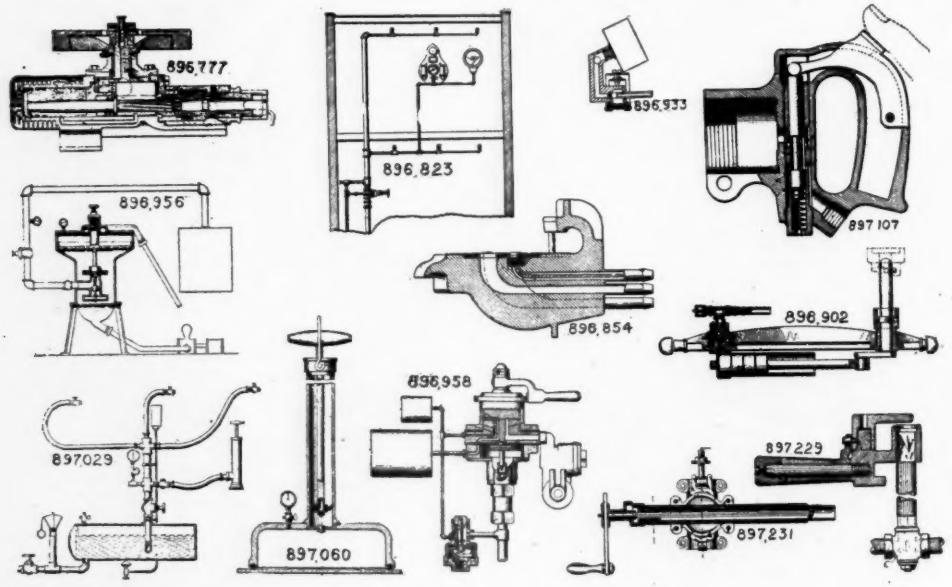
897,029. SPRAYING APPARATUS. HILLDRETH F. B. SNYDER, Mosier, Oreg.

897,060. LIFTING DEVICE. ROBERT W. CASH, Hannibal, Mo.

897,107. PNEUMATIC TOOL. WILLIAM H. KELLER, Philadelphia, Pa.

897,229. MECHANISM FOR CONTROLLING AIR AND SAND ON CARS. CLAUDE SPICER, Elyria, Ohio.

897,231. AUTOMATIC FLUID - ACTUATED FEED MECHANISM FOR PERCUSSIVE TOOL. DANIEL S. WAUGH, Denver, Colo.



PNEUMATIC PATENTS, AUGUST 25.